Information and context effects on consumers' food experience

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UNIVERSITEIT GENT

FACULTEIT BIO-INGENIEURSWETENSCHAPPEN

Don't regret anything you do,

because in the end it makes you who you are.

(Thirty Seconds to Mars – Closer To The Edge – Music Video)

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Information and context effects on consumers' food experience

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List of abbreviations

ANOVA: Analysis of variance

CA: correspondence analysis

CATA: check-all-that-apply

CLT: central location test

FAO: Food and Agriculture Organisation of the United Nations

FAVV: Federaal Agentschap voor de veiligheid van de voedselketen

HUT: home-use-test

JAR: just-about-right

MFA: multiple factor analysis

RATA: rate-all-that-apply

RATA-S: rate-all-that-apply scoring

TDE: Temporal Dominance of Emotions

TDS: Temporal Dominance of Sensation

VLAM: Vlaams Centrum voor Agro- en Visserijmarketing

Samenvatting

Wetenschappers en de voedingsindustrie maken reeds decennia gebruik van sensorisch onderzoek op levensmiddelen om zo de voedingskeuze te kunnen bepalen. Maar desondanks wordt men toch geconfronteerd met 80 tot 90% marktfalen voor nieuwe voedingsproducten. Dit heeft niet enkel een negatieve impact op voedingsbedrijven, waar de introductie van nieuwe voedingsproducten noodzakelijk is voor de economische rendabiliteit op lange termijn, maar ook voor wetenschappers en beleidspersonen. Sensorische onderzoek kan immers een belangrijke rol spelen om oplossingen te vinden voor grote maatschappelijke uitdagingen zoals de globale voedingszekerheid alsook gezondheidsproblemen zoals bijvoorbeeld obesitas.

Een mogelijke oorzaak van het marktfalen is het feit dat de bijdrage van consumenten traditioneel beperkt is in sensorische analyse tot hun algemene beoordeling van de voedingsproducten. Daarom zijn er het laatste decennium verschillende nieuwe methodes ontwikkeld die het mogelijk maken om de sensorische attributen te laten karakteriseren door consumenten, een taak die normaal voorbehouden is aan getrainde panelleden. Naast deze sensorische profilering door consumenten, vindt momenteel de emotionele profilering opgang bij zowel wetenschappers als de voedingsindustrie. Consumenten worden bij emotionele profilering gevraagd welke emotionele conceptualisaties ze ervaren tijdens de evaluatie van een voedingsproduct. Recent onderzoek heeft uitgewezen dat de inclusie van emotionele profilering bijdraagt om de algemene voedingskeuze beter te voorspellen. Hoewel beide profileringstechnieken complementair zijn, worden ze meestal niet samen toegepast wellicht om de deelnemers niet teveel te belasten.

Deze doctoraatsthesis combineert de emotionele en sensorische profilering om zo een beter zicht te krijgen op de voedingsbeleving van consumenten. Als eerste objectief van deze doctoraatsthesis werd een nieuwe methode, het EmoSensory® Wiel, ontwikkeld en gevalideerd om beide profileringstaken te combineren. Uit de resultaten blijkt dat deze tool kan aangewend worden voor de emotionele en sensorische profilering waarbij wordt aangetoond dat deze methode verschillen kan meten tussen producten met een gelijkaardige algemene beoordeling. Het wielformaat heeft geen impact op de profileringstaak en meer dan twee derde van de participanten prefereert deze tool in vergelijking met een traditionele vragenlijst.

Daarnaast is het belangrijk om te onderzoeken in welke mate de lage gelijkenis tussen traditionele sensorische testen met de reële consumptiecontext een rol speelt in de lage voorspellende waarde voor de effectieve voedingskeuze. Terwijl geweten is dat zaken als merk, nutritionele informatie en labels de voedingskeuze beïnvloeden, worden sensorische studies normaal uitgevoerd met blind-gelabelde producten. Dit houdt in dat consumenten geen enkele informatie ontvangen over het te evalueren product. Verder vindt sensorisch onderzoek

voornamelijk plaats in gestandaardiseerde labo-omgevingen waar aan consumenten gevraagd wordt om de producten te beoordelen in individuele testcabines. Het is duidelijk dat zo'n context weinig gelijkenissen vertoont met de reële consumptiecontext.

Daarom was de tweede doelstelling van deze doctoraatsthesis om te onderzoeken in welke mate informatie en de context een invloed hebben op de productbeleving.

Drie casestudies werden uitgevoerd om een licht te werpen op de tweede onderzoeksdoelstelling. Uit de eerste casestudy kwam naar voor dat de gezondheidsgerelateerde labels (bv. 'light', 'gereduceerd zoutgehalte') een invloed hebben op de sensorische perceptie van de gerelateerde sensorische attributen bij kaas. Zo werd kaas voorzien met een label 'kaas met gereduceerd zoutgehalte' door minder mensen als zoutig ervaren ten opzichte van gewone kaas terwijl de deelnemers dezelfde kaas evalueerden. Er was bijna geen impact van de labels op de emotionele profilering van de kaas hetgeen suggereert dat de emotionele profilering voornamelijk door de sensorische eigenschappen werd bepaald.

De tweede casestudy toonde aan dat ingrediënt informatie (insect / vegetarisch / vlees) slechts in beperkte mate een invloed had op de productbeleving van hamburgers gezien er weinig verschillen werden gevonden tussen de geïnformeerde en blinde evaluatie. Desalniettemin is het interessant om te vermelden dat de algemene waardering hoger was tijdens het geïnformeerd proeven voor de insectenburger en werd de insectenburger als voedzamer beoordeeld dan de hamburger bereid met vlees. Dit illustreert het potentieel voor de introductie van insectenproducten in België als strategie om verder de uitdaging van de globale voedingszekerheid aan te pakken.

In de derde casestudy werd de invloed van de context (labo vs. thuis) als merkinfo op de evaluatie van 5 commerciële aardbeienyoghurts onderzocht. Uit deze studie kwam naar voor dat de context voornamelijk een invloed had op de emotionele profilering terwijl merkinfo hoofdzakelijk een impact had op de sensorische profilering van de voedingsproducten.

Uit deze doctoraatsthesis blijkt dat het EmoSensory® Wiel door zowel wetenshappers als bedrijven ingezet kan worden om een beter beeld te krijgen van de productbeleving van consumenten. Terwijl wetenschappers deze tool kunnen aanwenden om consumenten-beoordelingen te verkrijgen om de voedingskeuze te bestuderen, kunnen voedingsbedrijven de informatie bekomen uit deze tool inzetten in het kader van productontwikkeling en marketing. De drie case studies illustreren dat zowel de potentiële impact van de presentatie van de stimuli als de context in acht dienen genomen te worden bij het opzetten en interpreteren van resultaten van sensorische onderzoeken.

Abstract

For decades, scientists and industry apply sensory research on food products to determine product choice. Nevertheless, about 80-90% of new food products fail in the market. This negatively effects food companies, which need successful new food products to guarantee economic durability on a long term but also impacts scientists and food policy makers. Thereby, sensory science could play an important role to find solutions for big societal challenges like global food security and major health problems (e.g. obesity).

A possible explanation for those high market failure rates is that consumers' contribution is traditionally limited to their overall hedonic assessment of food products. But the last decade some new methods were developed to let consumers characterise the sensory attributes of food products, a task which used to be reserved for trained assessors. Next to the sensory profiling by consumers, a growing number of scientists and food companies are also starting to incorporate emotional profiling of food products by consumers. For instance, participants are asked which emotional conceptualisations they experience when they evaluate a food product. Recent research found that the inclusion of emotional measurements helps to better predict food choice compared to the sole hedonic assessment. Nevertheless, they are generally not combined, most likely to prevent encumbering of the participants.

This doctoral thesis combines emotional and sensory profiling for obtaining a better view on consumers' food product experience. As a first objective of this doctoral thesis, a new method namely the EmoSensory® Wheel has been developed and validated in order to combine both profiling tasks. Results indicated that the method is able to discriminate between food products, even when both products have a similar overall acceptance. The wheel question format does not influence the results of the profiling task, while more than two third of the consumers prefer the EmoSensory® Wheel compared over a traditional list-based questionnaire format.

Further, it is important to examine whether the low resemblance of traditional sensory tests with an actual consumption context plays a role in the low predictive value of actual food choice. Although it is known that information such as brand, nutritional content and labels influences consumers' food choice, sensory tests are normally carried out with blind-labelled samples. This means that consumers do not receive any information of the products which they need to evaluate. In addition, sensory tests are often carried out in standardised labs where consumers are asked to evaluate products while seated in separate booths. It is clear that such context does not resemble a real consumption context. Therefore, the second objective of this doctoral thesis was to examine the potential influence of information and context on product experience.

Three case studies were conducted in the scope of the second objective. The first case study showed that health-related labels (e.g. 'light', 'reduced salt') influenced the sensory perception of related sensory attributes of cheese. For instance, cheese labelled as 'cheese with reduced salt content' was perceived by less people as salty compared to regular cheese (although consumers were actually evaluating the same cheese product). Emotional conceptualisations were almost not influenced by the labelling, hence the emotional profiling was sensory driven.

The second case study showed that content information (insect / vegetarian / meat) in burgers had only a limited effect on food experience as little differences were found between the informed and blind information. However, it is interesting to note that during the informed evaluation of the insect-burger the overall acceptance was higher than under the blind condition and people perceived this insect-based burger as more nutritious compared to the meat-based burger. This shows the potential of insect-based products for consumption in Belgium, as a strategy to further tackle the challenges of global food security.

A third case study uses five commercial strawberry flavoured yogurts to examine the potential influence of the context (central location test vs home-use-test) and brand information. While the context mainly influenced the emotional profiling of the samples, brand information impacted primarily the sensory profiling.

This doctoral thesis shows that both scientists and food companies can apply the EmoSensory® Wheel to get a better view on how consumers experience food products. Scientists may use this method to obtain consumers' opinions in the scope of research regarding food choice while food companies can implement this method during product development and for marketing purposes. The three case studies illustrate that the potential impact of the presentation of the stimuli and context should be carefully considered when setting up and interpreting results of sensory studies.

Part I

General introduction

Chapter 1

Introduction, objectives and outline of the thesis

1.1. General introduction

Sensory appeal is one of the most important motives among consumers for their food choice (Lawless & Heymann, 1998; Markovina *et al.*, 2015). Therefore, a lot of research about consumers' preferences and liking of food products have been conducted in the last decades by both scientists and food companies. The scientific discipline that studies the human evaluation of consumer products by the senses (taste, sight, smell, touch and hearing) is called sensory analysis (Lawless & Heymann, 2010).

Although consumer & sensory research is widely applied in mainly large food companies, the food industry is still confronted with high market failure rates of around 80% (Köster, 2012; van Kleef, van Trijp, & Luning, 2005) which raises concern about the sufficiency of current sensory methodologies to predict food choice. This means that a large majority of new or reformulated products is no longer in the shelves one year after the market introduction. These high failure rates do not only have implications for food companies who spend lots of money on both R&D and marketing, but also impacts the economy as companies need innovation to stay in business (Sarkar & Costa, 2008). Moreover, these low success rates also play a role for scientists who rely on sensory analysis in order to tackle global challenges like global health issues and global food security. For instance, these rates are a hurdle when scientists apply sensory research to investigate nutritionally balanced food products in order to challenge potential health problems related which are caused by an unbalanced diet (McKay & Mathers, 2011; Mente, de Koning, Shannon, & Anand, 2009)

Therefore, the question arises which measures can be taken in sensory research to better resemble actual food choice.

Firstly, sensory research should include additional measurements next to consumer acceptance (Meiselman, 2013). Reasoning behind this is that the concept of overall acceptability or liking cannot be seen as a sufficient benchmark for product success or sale prediction (Jiang, King, & Prinyawiwatkul, 2014). Therefore, researchers have started to include conceptual measurements next to overall acceptance in order to capture more information about consumers attitudes towards food products (Jiang *et al.*, 2014; Meiselman, 2015; Thomson, 2007). Scientific research on food products has mainly focused on the role of emotional conceptualisations on consumers' food evaluation. The development of a standardized emotional questionnaire list specifically for food products by King and Meiselman (2010) contributed highly to the emerging body of scientific studies to examine the emotional conceptualisations associated with food products (Köster & Mojet, 2015). Also the industry makes use of emotional conceptualisations for their product assessment. Kraft Foods' principal consumer scientist, Melissa Knorr, mentioned during the annual ITF meeting in 2011 that companies should include emotional measurements as traditional tools were no longer sufficient to answer all research questions. Knorr mentioned (Watson, 2011):

"Emotional profiling gave us critical direction. Traditional tools were not enough. We used emotional research to define unique points of difference and create a new hierarchy of attributes that go beyond 'liking'. The failure of consumers to make an emotional connection [to the reformulated product] was driven by changes to sensory attributes we hadn't measured before. In the test product, [positive] emotional attributes appeared early but were weak and faded fast, leading to a disappointing experience, so we reformulated again to get closer to the original sensory profile."

This suggestion has been supported by findings from several scientific studies where it turns out that emotional profiling could measure beyond overall liking by differentiating in products which have a similar overall liking score (Gutjar, de Graaf*, et al.*, 2015; King & Meiselman, 2010; Mojet *et al.*, 2015). But the inclusion of emotional profiling might not only offer new insights on how consumers experience food products but also help to better predict actual food choice (Dalenberg *et al.*, 2014; Gutjar, de Graaf*, et al.*, 2015). Emotional profiles can also be applied during consumer-led food product development for the SensoEmotional optimisation of food products (Thomson, 2007). The obtained emotional profiles make it is possible to strengthen the brand message and the sensory experience by ensuring that both are in consonance (Thomson, Crocker, & Marketo, 2010).

Secondly, sensory profiling is traditionally carried out by trained assessors (Meilgaard, Carr, & Civille, 2006). These trained assessors are among others selected based on their ability to detect sensory differences (Meilgaard *et al.*, 2006). After a long training period, often containing more than 100 hours, trained panellists are able to detect small differences in a specific product category. Although sensory profiling has its merits for product development and reformulation, one should bear in mind that actual consumers normally have less experience and might not be able to detect small differences. Further, while trained panellists are used to obtain a descriptive profile of the sensory attributes of products, they do not indicate to which extent the intensity of a sensory attribute is linked to the overall acceptance. Because of the aforementioned shortcomings and the fact that trained panels require serious investments in time and money, several new techniques have been developed the last decade to conduct sensory profiling with untrained panellists (Valentin, Chollet, Lelievre, & Abdi, 2012; Varela & Ares, 2012). With techniques such as the just-about-right (JAR) scale and the ideal scale (Li, Hayes, & Ziegler, 2014), it is possible to examine which sensory attributes are the drivers of liking.

Thirdly, sensory research tends to happen under controlled circumstances which of course differ from a realistic food consumption. For instance, sensory research focuses on the blind evaluation of a food product whereby panels and consumers evaluate the food product without any information as the aim is to examine solely the influence of the sensory attributes (Lawless & Heymann, 2010). However, taste and flavour can be perceived differently when additional extrinsic information is given to consumers (Okamoto & Dan, 2013). As an example, Coca Cola experienced this effect with a famous marketing blunder in the 1980's by changing

the taste formulation of its flagship product. The objectively better taste (New Coke) was subjectively perceived as worse by the consumers than the objectively poorer taste (original Coke) (Paasovaara, Luomala, Pohjanheimo, & Sandell, 2012). Noticing the effects of packaging on the sensory appraisal of food products, sensory research has started to broaden its perspective to a greater use of branded and packaged products to examine the influence of this information on the sensory evaluation (Fernqvist & Ekelund, 2014; Meiselman, 2013; Piqueras-Fiszman & Spence, 2015).

Moreover, sensory research tends to be carried out in central locations (CLT) which often is a laboratory environment as researchers want to control the environmental factors as much as possible (Meilgaard *et al.*, 2006). Although tests carried out in CLT settings have the benefit that they also make it easy to better compare results when tests take place in different locations (e.g. different regions / countries) and occasions, the evaluation of for instance 5 samples while seated in a sensory booth under standard lightning does not resemble the actual food consumption let along actual food choice. People are more aware of participating in a sensory test in such laboratory studies which potentially influences their sensory evaluation of the tested products (Boutrolle, Delarue, Arranz, Rogeaux, & Köster, 2007; Edwards, Meiselman, Edwards, & Lesher, 2003; Köster, 2003). But it is not only the physical evaluation context which influences consumers' food product experience but also the consumption context as emotional profiles can even be influenced when people are thinking about an imaginary consumption setting (Piqueras-Fiszman & Jaeger, 2014a, 2014b, 2014c). But there is little known what the potential impact is of the actual context on consumers' food product experience. Consequently, there is a need to obtain a better understanding to which extent the context influences the emotional conceptualisations and sensory perception (Danner *et al.*, 2016; Dorado, Chaya, Tarrega, & Hort, 2016; Jaeger *et al.*, 2016; Meiselman, 2013).

1.2. Scope and relevance of the topic

In this doctoral dissertation, the focus lies on examining the influence of information and context on consumers' food experience. Sensory and emotional profiles of food products will be determined by consumers in order obtain a better understanding on how regular consumers experience food products.

Although studies are stating that food product development needs to be consumer-driven (Costa & Jongen, 2006; Guerrero *et al.*, 2009; MacFie, 2007; van Kleef *et al.*, 2005), it is only recently that consumers are asked about how they perceive a food product by determining sensory and conceptual profiles (Thomson, 2015; Varela & Ares, 2012). However, there is a need for consumer-friendly research methods for elucidating and quantifying the key aspects of conceptual and sensory profiles (Asioli *et al.*, 2016; Thomson & Crocker, 2015). Therefore, a first objective of this doctoral thesis is the development of a method (called EmoSensory® Wheel) for the combined elicitation of sensory and emotional profiling of food products by consumers using a wheel questionnaire format. As Ng, Chaya, and Hort (2013a) addressed the need to combine self-reported emotional and sensory measurements to understand how sensory aspects of food products evoke emotions which drives food choice, the EmoSensory® Wheel can also help to offer insights in this scientific gap.

Further, three case studies are presented in this PhD which apply this newly developed method. This leads to the second objective of this doctoral thesis: examining the potential effects of information and context on the emotional and sensory profiling. The main rationale behind these case studies is to demonstrate the usability of the new method and to obtain a better understanding of which factors might influence the measurements. Hence, the second objective is related to the ecological validity (Schmuckler, 2001). Results obtained from these case studies are therefore not only of importance for scientists, they are also of interest for the food industry as they might explain potential measurement biases due to the research methods.

(1) A first case study explored the influence of health-related labels on the quality perception and EmoSensory® profiling of cheese. Nowadays, several food products contain front-of-pack labelling (e.g. reduced in salt, 'light', low-fat) to target health-oriented consumers. While sensory appeal is the most important driver for food choice in several countries, health is listed as the second one in Belgium (Januszewska *et al.*, 2012). Regular gouda cheese was chosen as product of interest as cheese is an important source of dietary calcium, proteins and also vitamins in most Western countries (Czarnacka-Szymani & Jezewska-Zychowicz, 2015; Keast, Fulgoni, Nicklas, & O'Neil, 2013; Lucas *et al.*, 2006; O'Neil, Keast, Fulgoni, & Nicklas, 2012). However, most cheeses have a rather high fat and salt content (Lucas *et al.*, 2006). Therefore, new cheese products have been launched to address health conscious consumers such as light cheeses (associated with a lower fat content) and low-sodium cheeses. In order to really understand the influence of health-related labels, all consumers were offered

unknowingly samples of the same cheese product. Because of this, we assessed the sensory perception during the informed condition.

(2) The second case study examined the influence of information about the burger composition on consumer's food experience. Samples of three commercial burgers were used during this study: meat-based, plant-based and insect-based burgers. The rationale behind this study was to compare the product experience of a rather novel product, the insect-based burger, with two regular products. Insects are seen as an interesting feed and food source across the world, mainly for their potential contribution towards ensuring global feed and food security for future decades (FAO, 2013). Although edible insects are part of the diet of around 2 billion people, consumer acceptance of insect-based products is rather limited in Western countries (van Huis, 2013; Verbeke, 2015). But scientific studies which include the sensory evaluation of insect-products in a Western country are rather scarce.

(3) A third case study investigated the influence of brand information on the emotional and sensory assessment of yogurt products. Brands are used to distinguish food products of each other and are therefore of importance for marketing. As consumers most often buy food products out of habit (Köster, 2009), companies apply branding to distinguish them from other products but also provides a long-lasting sense of purpose and meaning to a targeted group of consumers (Cavanagh & Forestell, 2013). Yogurt products were chosen for this case study because previous research on emotional profiling has primarily worked with highly likable snack products such as chocolate, crackers and sugared beverages (Jiang *et al.*, 2014).

1.3. Selected underlying theories and conceptual framework

This part first discusses the food choice process model (Sobal & Bisogni, 2009) which is widely used to explain several components influencing consumers' food choice behaviour. Further, a number of theoretical frameworks regarding food quality are included in this section given the importance of food quality as motive for food choice according to the food choice process model (Sobal & Bisogni, 2009). Conceptualisations, also known as conceptual associations (Thomson et al., 2010) or implicit associations (Greenwald, Klinger, & Schuh, 1995), are also discussed in this section given their value for food choice (Sobal & Bisogni, 2009). The differences between the concepts of liking and wanting are also deliberated in order to provide a broader view on how these two psychological factors play a role in food choice.

1.3.1. Food choice process model

Although food choices are often seen as mundane and arbitrary, the decisions are frequent, multifaceted, situational, dynamic and complex of nature (Sobal & Bisogni, 2009). A food choice process model has been proposed by Furst, Connors, Bisogni, Sobal, and Falk (1996) based upon qualitative research methods. An improved version of this model has been developed using additional data gathered by the same research team (Sobal and Bisogni (2009), Figure 1.1).

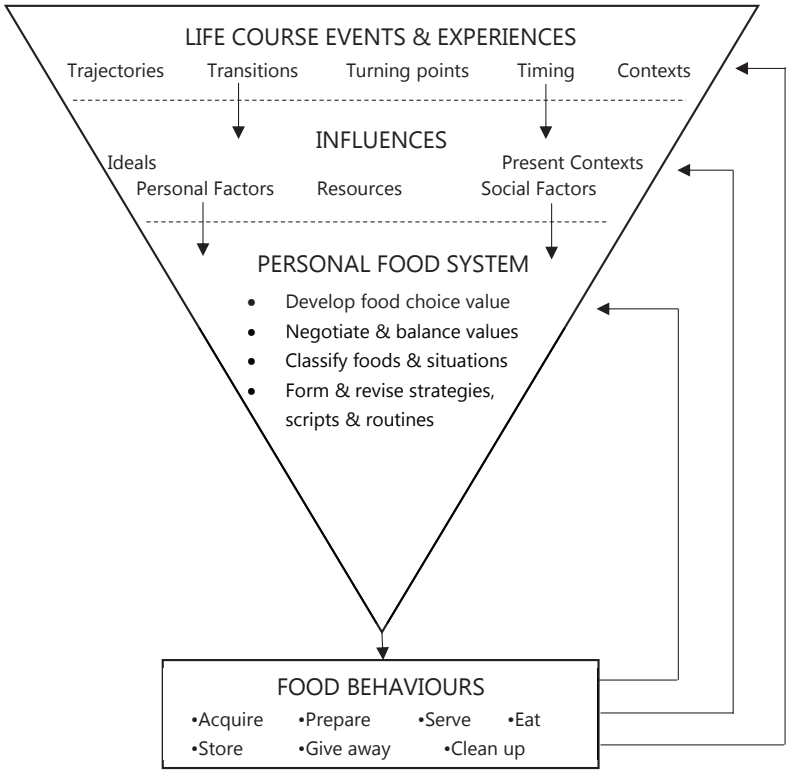

Figure 1.1 Food choice process model (Sobal & Bisogni, 2009)

Three main components can be distinguished which operate together and influence food choice behaviour in this model: (i) life course events & experiences, (ii) influences and (iii) personal food system. The next paragraphs describe each component more into detail.

The first component include several ***life course events and experiences*** prior to the present food choice. Consumers will anticipate and have certain expectations regarding future food choice decisions based upon these events and experiences (Elder, 1985). Life course events & experiences are broader defined in this model than simply life cycle development and progression trough the several life stages as it also includes several dynamic processes exceeding life stages (e.g. trajectories, transitions, turning points, timing and contexts). **Food choice trajectories** are considered as persistent thoughts, feelings, strategies and actions when a person loomed food choice (Devine, Connors, Bisogni, & Sobal, 1998). Family cuisine and food preferences as a child for instance, will have an impact on food choice decisions for the rest of a person's life. However, certain changes can happen in food choice trajectories due to shifts in a person's life course. Significant life events (e.g. retirement, change of work,…) leading to differences in food choice trajectories are called **transitions**. On the other hand, **turning points** are major transitions evoking a major reconstruction of food choice such as shifting from a regular diet to a more sugar-free diet following the diagnosis of diabetes. The age and cultural norms will influence how people react on certain life course changes, which illustrates the importance of **timing** when life course events happen. Context is in the food choice process model defined as the social, cultural, political, economic and other conditions which can either facilitate changes or constrain constancy in food choice trajectories (Furst *et al.*, 1996).

A divergent range of elements will impact a person's food choice. Furst *et al.* (1996) grouped these elements into five categories (ideals, personal factors, resources, social factors and present contexts) which are part of the second component of the food choice process models, namely the ***influences***. These influences are situated within the life course, mutually shape each other as well as reinforce, interact, and compete with each other. For every category, a definition is provided by Furst *et al.* (1996) or Sobal and Bisogni (2009):

- **Ideals**: expectations, standards, hopes and beliefs that are points of reference and comparison by which people judged and evaluated food choices (Furst *et al.*, 1996). These ideals are also heavily determined by cultural effects and symbolic meanings (Furst *et al.*, 1996). For instance, insects are seen in Western countries as 'bugs' which makes it hard to incorporate edible insects as a food source in a Western diet because other people won't find it appropriate.
- **Personal factors**: attributes or characteristics of individuals that influence their food choice decisions and behaviours (Sobal & Bisogni, 2009). Personal factors include physiological factors (e.g. sensory sensitivity to certain tastes), psychological factors (e.g., food preferences, personality) and social factors (e.g. gender roles, parent responsibilities) (Sobal & Bisogni, 2009). The importance of personal factors lies in the

fact that these factors are setting boundaries regarding the food choices that an individual are willing to make as it includes likes/dislikes, individual food styles, cravings and emotional aspects (Furst *et al.*, 1996).

- **Resources**: assets available to individuals for making food choice decisions (Sobal & Bisogni, 2009). Many types of assets are available and these include various forms of capital such as financial capital (income, money), material capital (equipment, transportation, space), human capital (skills, knowledge), social capital (relationships, connections) and cultural capital (values, traditions) (Sobal & Bisogni, 2009).
- **Social factors**: relationships of individuals that can restrain or facilitate food choice decisions. Eating occurs often together with other persons and as a consequence food decisions are often made by a group after negotiating with other individuals .
- **Contexts**: the broader environments influencing food choice decisions (Sobal & Bisogni, 2009). Contexts include both social environments and physical environments in the food choice process model defined by Sobal and Bisogni (2009).

Individuals will develop their own ***personal food system*** throughout their life course. Sobal and Bisogni (2009) defines the personal food system as cognitive processes for food choice that guide eating behaviours including the development of food choice values, negotiation and balancing of food choice values, classification of foods and situations; development of strategies, scripts, and routines for recurring food decisions. **Food choice values** are a crucial part in the personal food system. Individuals do not only consider several factors during the valuation of food choice such as taste, cost, quality but also particular meanings and feelings they associate with these food products (Furst *et al.*, 1996; Sobal & Bisogni, 2009). These food choice values will change throughout life course and are also dependent of the context of the food choice (Sobal & Bisogni, 2009). Individuals will **negotiate and balance** all the different food choice values given what is important to them at that specific time given the specific context (Furst *et al.*, 1996). Interesting in the food choice process model is the idea that persons will simplify their food choices by **classifying foods and situations**. The characteristics of the food products, the contexts and their personal experiences (in casu their preferences) will be the leitmotiv for this classification (Blake, Bisogni, Sobal, Devine, & Jastran, 2007; Furst *et al.*, 1996). Individuals will use the classification as a necessary method to determine edible food products and among edible products to decide what to consume where, when, and with whom (Connors, Bisogni, Sobal, & Devine, 2001). This classification is important given the complex food system with many acceptable food choices and the limited amount of time most people spend to make food choices (Furst, Connors, Sobal, Bisogni, & Falk, 2000).

One of the most important food choice values, according to the research of Furst *et al.* (1996), is the **quality** of food products. Although people might have a different understanding of the concept of quality, Furst *et al.* (1996) concludes that there is a common denominator about what quality is as it appeared to hinge upon their feelings about, or visions of, some standard of excellence. Further, the associations people make with food products are often very

important for their food choice (Furst *et al.*, 1996). These associations are better known under the term **conceptualisations** in recent scientific literature in the field of food sciences (Thomson, 2007). Examples of such conceptualisations are for instance emotional terms like 'happy' and 'fear' but also more abstract terms such as 'healthy' and 'expensive'. Lastly, one should also consider the importance of the personal factors on food choice which includes **liking** but also considers **wanting**. While liking is more the core hedonic impact, wanting is seen as the (pre)conscious craving and desire for a certain product (Tibboel, De Houwer, & Van Bockstaele, 2015). Given the importance of quality, conceptualisations, liking and wanting for food choice, the next three sections delve deeper into respectively food quality models (1.3.2.), conceptualisations (1.3.3.) and the concepts of liking and wanting (1.3.3.).

1.3.2. Food quality models

The **extended quality guidance model** (Steenkamp (1990), Figure 1.2) is often seen as the first unified framework for analysing quality evaluation of food products. This model is the result of several studies examining the link between different approaches for assessing the perceived food quality by consumers.

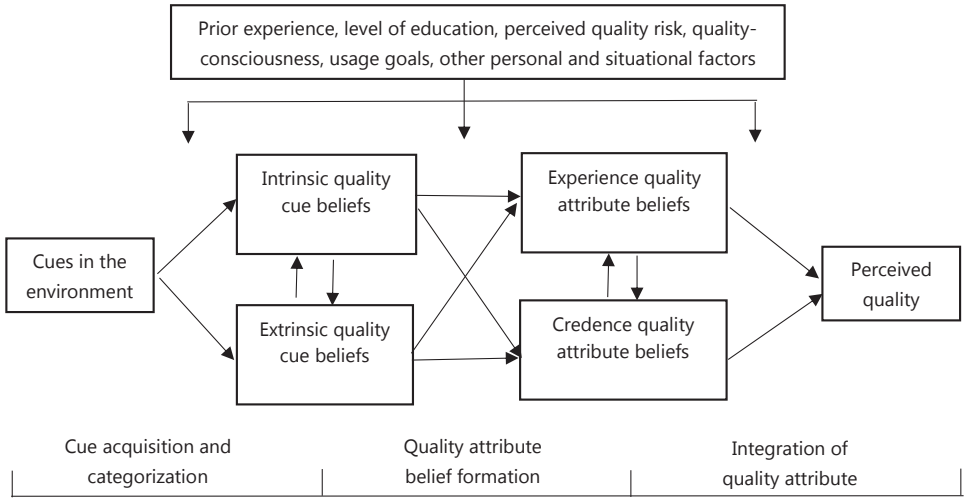

Figure 1.2 Extended quality guidance model (Steenkamp, 1990)

The extended quality guidance model starts with the fact that quality cues in the environment can be spotted by the senses prior to consumption. On the other hand, quality attributes are benefit-generating product aspects which cannot be experienced before consumption. Findings by Steenkamp suggest that the overall perceived quality perception is based upon those quality attribute beliefs perception. This model distinguishes two types of quality cues:

(i) intrinsic and (ii) extrinsic quality cues. *Intrinsic quality cues* are cues which a food product possess like for instance colour, appearance, shape. *Extrinsic quality cues* are also part of the product, but they are not physically part of it in contradiction to intrinsic quality cues. Brand name, price, nutritional content information are examples of extrinsic quality cues. Quality attribute beliefs are categorized as either (i) experienced or (ii) credence attribute beliefs. While *experienced quality attribute beliefs* can be realized because of the actual consumption of the product, *credence quality attribute beliefs* cannot be ascertained even after multiple consumptions. Examples of credence quality attribute beliefs are for instance fair trade, healthfulness, animal friendliness. Further, it is well-known that *personal and situational factors* interfere with the beliefs. Although this influence has been included in the extended quality guidance model of Steenkamp (1990), its importance for the perceived quality is more clearly present in the Quality Quadrant (Oude Ophuis & Van Trijp, 1995) (Figure 1.3).

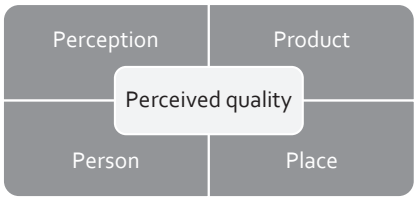

Figure 1.3 The quality quadrant (Oude Ophuis & Van Trijp, 1995)

While scientists agree that perceived quality must be seen as an overall and global concept, the **quality quadrant** lists four modalities which are an important part of it. These so-called 4 P's are: (i) perception (ii) product (iii) person and (iv) place. First of all, perceived quality is the result of the overall judgment or perception of a consumer. The overall perception is the outcome of the consumers' judgement based upon the product characteristics. These characteristics may have been experienced or the consumers associates these with the focal product. While perception plays an important role, it should be taken into account that also the product, place and person are utmost important for the perceived quality. The components of perceived quality will differ depending on the product or product category which is of interest. Also, each person is unique and differs in perceptual abilities, personal preferences and experience level which evidently will influence the perceived quality. Further, place or location also influences the perceived quality. Think about the difference between eating a meal alone at home or in a restaurant in the company of some nice people.

Next to the perceived quality (also sometimes referred as the subjective quality), Oude Ophuis and Van Trijp (1995) introduce the concept of *objective quality.* The objective quality refers to objective measurable and verifiable qualities of food products and can be determined by instrumental measurements. Examples are for instance the pH-value, fat content, colour and viscosity.

The distinction between objective and subjective quality is the basis for **Total Food Quality Model** (Grunert, Larsen, Madsen, and Baadsgaard (1996); Figure 1.4). This framework distinguishes two situations: first a shopping situation and second the situation in which a person prepares and consumes the food product which leads to the assessment of the experienced quality. Three types of cues are mentioned in this model: (i) intrinsic quality cues, (ii) extrinsic cues and (iii) cost cues. Of all the cues consumers are exposed to, only those which are perceived will have an influence on the expected quality. The expected quality will also be influenced by prior experiences with the food product (category). This model integrates *consumer behaviour theory* by introducing the concept of consumer satisfaction. When there is no discrepancy by the expected and experienced quality, consumers' motives will be fulfilled which will lead to future purchases. The Total Food Quality Model (Grunert, 1996) depicts that food quality must not be seen as an aim in itself, but is desired because it helps consumers to satisfy their motives.

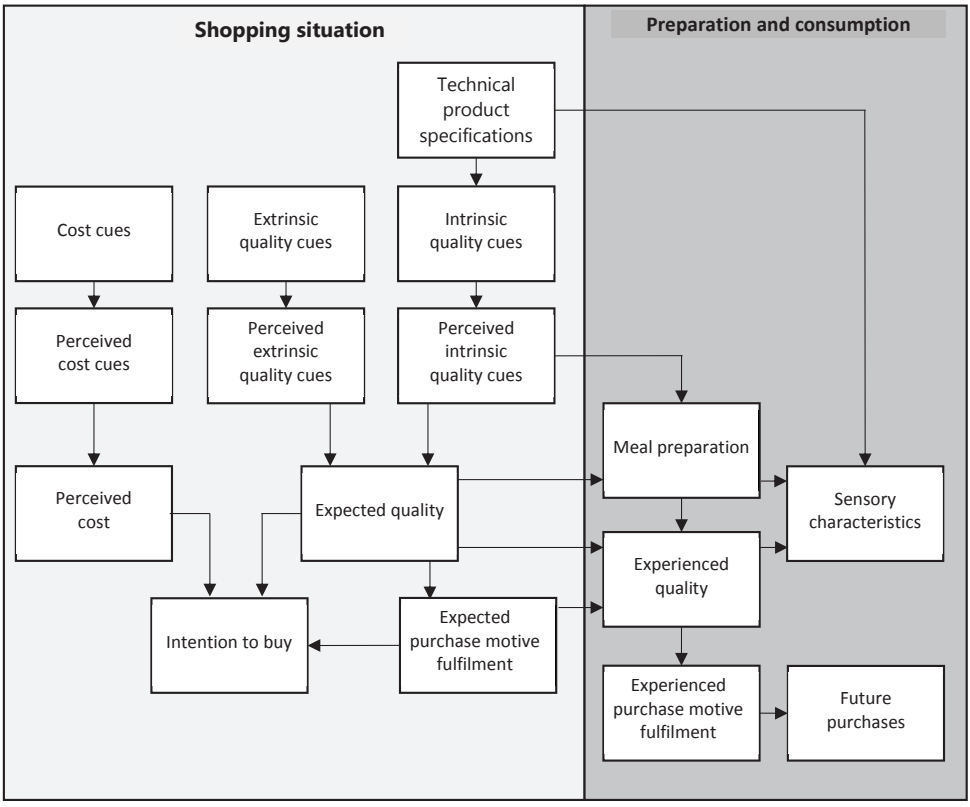

Figure 1.4 Total Food Quality Model (Grunert, 1996)

One shortcoming of the consumer quality perception process as described in the Total Food Quality Model (Grunert *et al.*, 1996) is that it does not include credence cues. Given the growing importance of credence cues like 'organic' and 'light' to distinguish food product from competitors, Fernqvist and Ekelund (2014) proposed a conceptual framework regarding the **food quality perception process** incorporating 'credence cues' and their role in quality expectations (Figure 1.5).

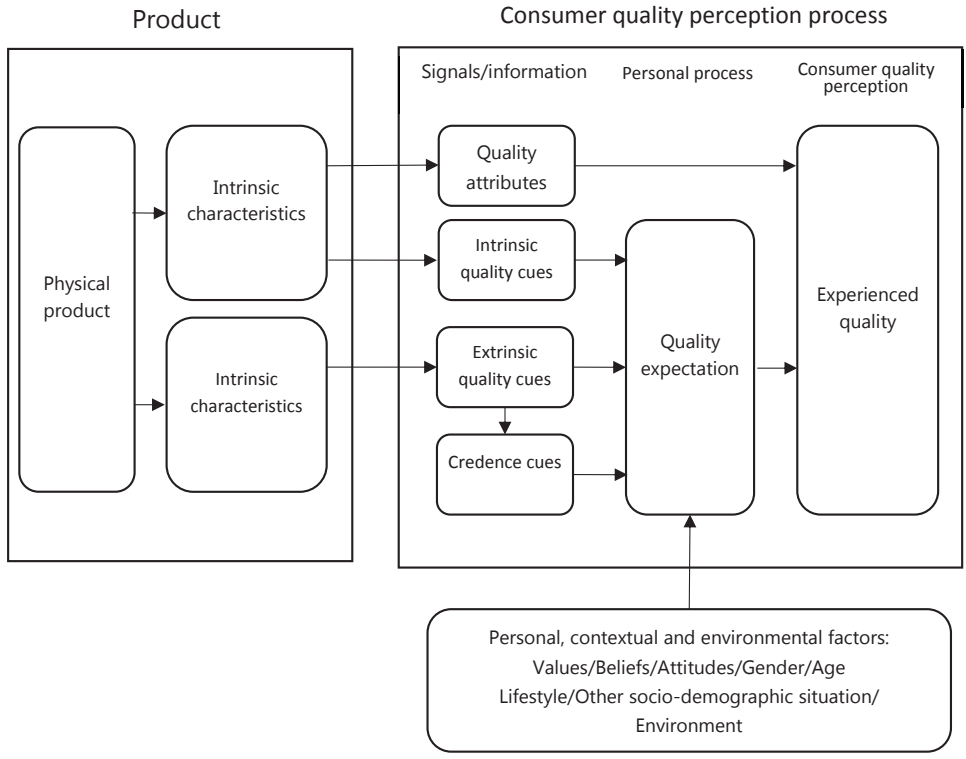

Figure 1.5 Model illustrating the role of credence cues in consumers' quality perception process (adapted from Fernqvist and Ekelund (2014))

1.3.3. Conceptualisations and their role in food choice

This part describes the nature of conceptualisations, also known as conceptual associations (Thomson *et al.*, 2010) or implicit associations (Greenwald, Klinger, & Schuh, 1995), and how these might be elicited and their role in food choice behaviour.

Simply stated, the reason that products fail is the lack of consumers' **motivation** to buy the product (Thomson & Crocker, 2015). It is motivation, either conscious or non-conscious, that drives humans to attain their goals (Higgins, 2009; Maslow, 1987). The fundamental goal that drives human behaviour is obtaining reward (Berridge & Kringelbach, 2008; Gendolla & Brinkmann, 2009). As a consequence, consumers will be motivated to buy the food products that will derive the most effectively **reward** (Thomson & Crocker, 2015).

Behaviour can be seen as the result of mental activity while sensory stimulation is the triggering input (Thomson, 2015). Intrinsic cues of the triggering stimulus are perceived by the human senses and are transduced into patterns of electrical activity which are in their turn transmitted via neurons to various brain locations. Next, this physiological activity is translated into mental activity (Carey, 2009) which happens mostly unconscious (Ellis & Newton, 2010). The first conscious awareness typically occurs when a person obtains mental representations of the triggering stimulus. But one need to bear in mind that a person can already be influenced unknowingly by unconscious mental activity before the first conscious awareness (Thomson & Crocker, 2015).

Object representations can historically be deconstructed into three aspects: (1) percept (what something is), (2) concept (what something means to us) and (3) affective reaction (how much reward or pleasure it brings) (Carey, 2009). When applying this on a blue candy, the perceptual characteristic of the surface of the object is blueness (if the form of the object is ignored). Having a closer look, the candy might also reveal hints of other colours like yellowness, lightness-darkness, glossiness and even some aromas could be distinguished. These characteristics are then the perceptual or sensory characteristics of the candy. Further, a blue candy also has associated meaning for a person like happy, guilt, unhealthy, expensive, liberalism etc. These associated meanings are conceptualisations and the nature and strength of those depend on the nature of the object, the cultural background of the individual and context (Thomson, 2015).

The psychological process starts when an object triggers the senses which influences perception, conceptualisation and finally leads to a conscious affective experience (liking) as visualized in Figure 1.6. Conceptualisations of the object will lead to emotional responses which on their hand lead to positive or negative rewarding outcomes. Ultimately, consumers' behaviour is driven by the net reward provoked via both conscious and non-conscious paths (Thomson & Crocker, 2015).

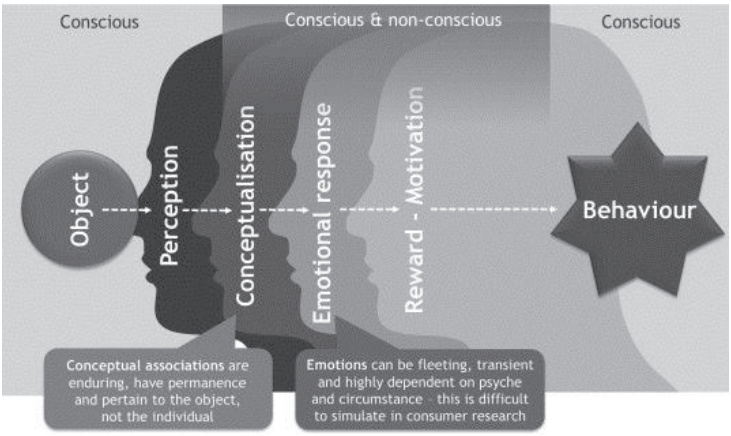

Figure 1.6 Model linking sensory stimulation to consequent behaviour (Thomson & Crocker, 2015)

Conceptualisations can be classified into three specific categories (Thomson *et al.*, 2010):

- Emotional conceptualisations: e.g. happy, glad, surprise, sad, worried
- Functional conceptualisations: e.g. cheap, controlling my weight, refreshing, healthy
- Abstract conceptualisations: e.g. artificial, ethical, modern, traditional, feminine

Emotional conceptualisations are related to feelings. When a person consumes a food product or even just sees a branded product, certain feelings like happiness and / or guilt might be experienced. Moreover, it is possible that a certain object makes a person to feel in a certain way without really experiencing that emotion consciously at that time (Lane & Nadel, 2002).

It is important to understand that there is a clear distinction between emotional conceptualisations and emotions as this has implications both on scientific level (research methodology) and industry level (product development and marketing). Although there is a lack of a clear scientific definition of emotion (Köster & Mojet, 2015; Lane & Nadel, 2002; Thomson & Crocker, 2013), there is a consensus that an emotion is something experienced by an individual and that the emotion (or the state of action readiness that it triggers) is apparent when the event actually takes place (Thomson & Crocker, 2015). In other words, emotions have been described as brief, fleeting, intense and heavily dependent on the context which makes it a challenge to mimic emotions in a research environment (King & Meiselman, 2010; Ng & Hort, 2015; Thomson, 2015). Emotional conceptualisations on the other hand, are retained in the memory so they have more permanence. Further, conceptualisations are also more related to the object instead of the individual while emotions are highly dependent on the mood of the individual.

Emotional conceptualisations are typically classified in three broad categories based upon their outcome: (i) positive, (ii) negative or (iii) unclassified (sometimes referred to as 'neutral') (Jiang *et al.*, 2014). Classification is usually based upon a grouping made by participants of the

research or based upon prior research and literature as for instance Desmet and Schifferstein (2008); King and Meiselman (2010); Laros and Steenkamp (2005).

Functional conceptualisations refer to those conceptualisations related to anticipated functional consequences. For example, sugar is seen as fattening, invigorating, causing tooth decay and causing diabetes which can all be seen as functional conceptualisations. However, actual functionality and conceptualised functionality are not necessarily the same as products might not deliver the functionality which a person conceptualises. When a product is not able to deliver the functional consequences expected by the consumers, it could influence future product choice and eventually influence food choice behaviour.

Abstract conceptualisations are really depending on the point of view of the individual consumer. Going back to sugar for example, the idea that sugar is unhealthy or good depends on the beliefs of the person. Another example is for instance the speculoos biscuit. While most Belgian consumers will label this as a 'traditional', this would not be the case for an Australian consumer. Some abstract conceptualisations may have an emotional connotation and therefore also influence emotions. For instance, a food product which has been found 'sophisticated' could lead to feelings like 'superior' and 'successful' associated with the product (Thomson *et al.*, 2010). Other abstract conceptualisations could be linked to potential functional outcomes as a brand which focuses on the production of nutritionally balanced dairy products might be abstractly conceptualised as 'healthy' which is of course linked to the functional properties of the products. This suggests that abstract conceptualisations can be seen as intermediary associations towards emotional and functional conceptualisations and that all conceptualisations can be organized into two broad categories based upon their connotations (Thomson *et al.*, 2010):

- conceptualisations that have emotional connotations (emotionality)
- conceptualisations that have functional connotations (functionality)

Based upon the above-mentioned, it is clear that consumers' food product choice is not only influenced by what they perceive and like, but also on what they expect or anticipate. Therefore, it can be hypothesised that conceptualisations will influence consumers' food choice, either conscious or non-conscious. In order to get a better understanding on the role of consumers conceptualisations of food products, this doctoral thesis opted to focus more specific on emotional conceptualisations to make an in depth research possible. Furthermore, research has shown that the inclusion of emotional conceptualisation measurements better predicts food choice compared to the sole (and traditional) evaluation of overall acceptance (Dalenberg *et al.*, 2014).

The link between emotional measurements, intrinsic cues, extrinsic cues and food choice has been examined by Gutjar, Dalenberg*, et al.* (2015) using an experiment with breakfast drinks. This resulted in a comprehensive model visualised in Figure 1.7. Similar to the models depicted in section 1.3.2., this model start with a distinction between intrinsic and extrinsic cues

generated by a food product. These cues influence the liking or acceptance of the product which impacts food choice and intake. But the main novelty is that this model also integrates the influence of emotional measurements, obtained by the standardized questionnaire EsSense Profile™ (King & Meiselman, 2010). These measurements were influenced by intrinsic and extrinsic cues which influenced both food choice and intake. The emotional measurements could be decomposed in two different dimensions during this study: (i) valence and (ii) arousal.

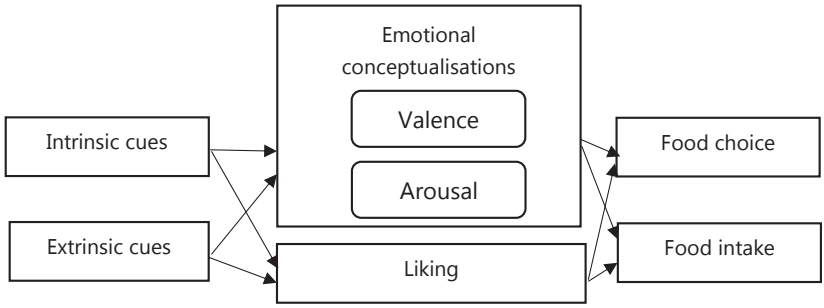

Figure 1.7 Model showing how food-evoked emotional responses and liking contribute to food choice and intake (adapted from Gutjar, Dalenberg, et al. (2015))

1.3.4. Liking and wanting

Psychological factors are undoubtedly important when an individual makes his or her food choice (Köster, 2009). The psychological factors are derived from a personal needs and desires which also leads to the individual's food preferences (Furst *et al.*, 1996). Therefore, it is important to introduce two important concepts related to the psychological aspects influencing food choice in this doctoral thesis namely 'liking' and 'wanting'.

Both liking and wanting are considered as key components driving eating behaviour based upon the process of reward (Dalton & Finlayson, 2014). According to the incentive salience theory, reward consists of a motivational (wanting) and hedonic (liking) component which are controlled by different brain mechanisms (Berridge, 1996; Berridge & Robinson, 2003). Therefore, food choice is determined by more than the hedonic experience during the reward consumption. The interactions between an individual's brain state (e.g. increased level of mesolimbic dopamine) or physiological state (e.g. hunger / satiety) and environmental elements (e.g. food availability) will lead to dynamically computations of wanting reflecting the real internal state (at a given time) in respect to an ideal set point with the goal to reach a homeostatic balance (Pool *et al.*, 2016). A psychological state of hunger might for instance increase the wanting of a food reward that becomes more wanted and liked (Havermans, Janssen, Giesen, Roefs, & Jansen, 2009). But the level of wanting might differ for the products at the specific time due to the environmental elements; a person could be wanting to eat an

expensive beef steak but chooses to eat a cheaper pork sausage instead as it the beef steak is too expensive at that time in the restaurant.

Liking and wanting can be both **processed** both at an **implicit** and **explicit** level (Berridge & Robinson, 2003). While explicit and implicit liking are referring to the same (potential) hedonic impact of the consumption, different psychological mechanisms are the base for explicit and implicit wanting (Pool *et al.*, 2016). Explicit wanting, also called cognitive desires, relies on a goal-directed system while implicit wanting relies on a Pavlovian system (Berridge & Robinson, 2003). Expectations about the pleasantness of the product, based upon previous experiences, play an important role for the cognitive desires while implicit wanting is potentially independent of the expected pleasantness (Berridge & Aldridge, 2008; Pool *et al.*, 2016).

The differences between the liking and wanting components have been studied extensively for several products during the last decades, also within the scope of human appetitive behaviour (Finlayson & Dalton, 2012; Pool *et al.*, 2016). However, contradictory results have been reported during human experiments which is sowing a seed of doubt about the existence of separate wanting and liking influences in human rewards processing (Havermans, 2011; Pool *et al.*, 2016). A recent systematic review of the methodologies used to assess wanting and liking suggests that this might be due to the fact that numerous studies **measured** human wanting and liking not in an **adequate** way (Pool *et al.*, 2016). The review by Pool *et al.* (2016) stresses the necessity to measure human **wanting** after or during the perception of a reward-associated cue given that the synergetic combination of the cue and the physiological state is necessary to trigger wanting. If an individual in a particular physical state does not experience a cue, he or she will not have wanting behaviour (Tindell, Smith, Berridge, & Aldridge, 2009). Also when the encountered cue is not relevant given the physiological state, for instance showing a bottle of water when one is not thirsty, then an individual will not show any wanting behaviour (Zhang, Berridge, Tindell, Smith, & Aldridge, 2009). More than one third of the studies included in the systematic review by Pool *et al.* (2016) did not measure wanting during or after the perception of a real or vividly imagined cue and are therefore unlikely to truly reflect the wanting. Similar to wanting, Pool *et al.* (2016) also encountered problems with **liking** measurements in several reported studies. Given that the incentive salience theory defines liking as a person's hedonic experience of the consumption or the receipt of a reward (Berridge, 1996; Berridge & Aldridge, 2008; Berridge & Robinson, 2003), experiments should measure liking during or immediately after the consumption (Pool *et al.*, 2016; Tibboel *et al.*, 2015). In almost half of the studies included in the systematic review of Pool *et al.* (2016), no reward was presented (but merely reward cues) or questions were related to expected, remembered or imagined likability instead of letting an individual assess their actual liking of the reward.

Nevertheless the incongruent use of liking and wanting measurements in a considerable number of studies, Pool *et al.* (2016) suggests that a major source of confusion might be due to **expected pleasantness**. Expected pleasantness is an individual's evaluation about how good or bad a particular cue is going to be, given the psychological state he or she is in, which

are cognitive desires based upon past episodic memories of liking experiences with the presented cue or reward (Pool *et al.*, 2016). Based upon this, Pool *et al.* (2016) developed a theoretical framework to visualise the mechanisms involved in wanting and liking (Figure 1.8). This framework is in line with the incentive salience theory which makes a **distinction** between (a) **implicit wanting** (or incentive salience) based on the Pavlovian system and (b) **explicit wanting** (or cognitive desires) based on a high-level goal-directed system (Berridge & Aldridge, 2008; Zhang *et al.*, 2009). The interaction between the perception of a reward-associated cue with the relevance of this cue to the current state will determine the implicit wanting of an individual. Liking is defined as the hedonic experience of a an individual during consumption or receipt of the reward. This liking will then influence the expected pleasantness when an individual is presented with a reward-associated cue based upon prior experiences which will affect the cognitive desires or explicit wanting.

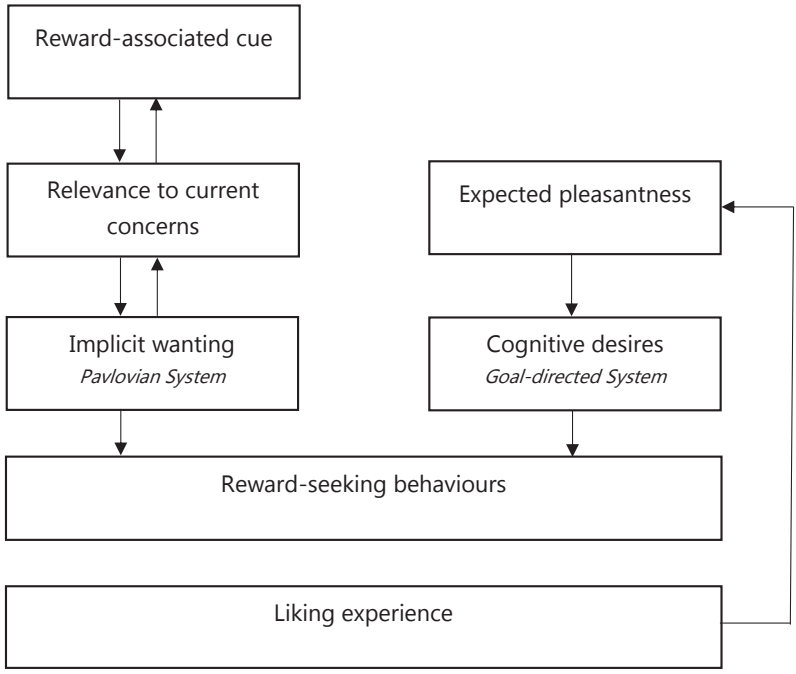

Figure 1.8 Theoretical framework of the mechanisms underlying wanting and liking (adapted from Pool et al. (2016))

1.3.5. Conceptual framework

A conceptual framework (Figure 1.9) has been established based upon the theories discussed in sections 1.3.1 - 1.3.4. This framework describes how the physical characteristics of a product are just the starting point to the individual's final food choice by incorporating several influencing factors based upon the previous sections. It considers a multidisciplinary perspective as it includes theories and methodologies from the fields of psychology, food, consumer and sensory science. These theoretical concepts are commonly used in scientific research on consumers' food product perceptions and consumer behaviour studies to examine their impact on food choices. The main structure of this conceptual framework is largely based upon the consumer quality perception process (Fernqvist & Ekelund, 2014) expanded with the influence of product evoked emotions (Gutjar, Dalenberg*, et al.*, 2015; Thomson & Crocker, 2015) and the theoretical framework of mechanisms underlying wanting and liking (Pool *et al.*, 2016).

Although this conceptual framework provides a broad overview on several factors leading to food choice, this doctoral thesis is limited to study food experience. However, the other concepts in this conceptual framework are important to obtain a better understanding on the contribution of this doctoral thesis to extending the existing theories and models related to food choice. First, the concept of food experience will be discussed in the next part 1.3.5.1. Second, this doctoral thesis delves deeper into the subjective product quality to understand how the overall quality judgement is based upon the interplay of intrinsic, extrinsic and credence cues (1.3.5.2.). Lastly, the role of product evoked emotions in food choice will be explained (1.3.5.3.).

1.3.5.1. The concept of food experience

A distinction has been made between the **objective** (left side of the framework) and **subjective product quality** (right side of the framework) in this framework. While the objective product quality origins from the physical product characteristics, the subjective quality is the result of the human perception of the product performance by evaluating the product though a 'perception filter' (Risvik, 2001). However, consumer's food choice is not solely based upon the subjective experienced food quality, which is mainly measured by determining their overall acceptance of the product (Lawless & Heymann, 2010; Meiselman, 2013). Therefore, this conceptual framework proposes the inclusion of *emotional* measurements which, in combination with the overall acceptance, provide a better prediction of the food choice (Dalenberg *et al.*, 2014; Gutjar, Dalenberg*, et al.*, 2015).

Although there is a trend to let consumers perform sensory profiling during the last couple of years, this task is traditionally executed by trained assessors in the scientific field of sensory science (Varela & Ares, 2012). Nevertheless, research indicated that sensory profiles obtained by consumers are similar to those of trained panellists (Adams, Williams, Lancaster, & Foley, 2007; Ares *et al.*, 2015; Bruzzone, Ares, & Giménez, 2012; Moussaoui & Varela, 2010). Sensory profiling by consumers is currently treated as a complementary method to sensory and

consumer science, as they can be applied to gather product descriptions directly from consumers (Varela & Ares, 2012). It also has the benefit of having direct feedback from them which is of interest as consumers are still the persons who finally are targeted to buy the food products. Together with the emotional profiling, the concept of **food product experience** is introduced in this conceptual framework. Food product experience is the result of the combined sensory and emotional profiling of food products by consumers.

Consumer's food experience is also influenced by the **personal and situational factors** occurring in a **contextual setting** (Jiang *et al.*, 2014; Köster, 2009; Köster & Mojet, 2015; Meiselman, 2006; Oude Ophuis & Van Trijp, 1995). Personal values, beliefs, attitudes and demographics are typical examples of personal factors (Steenkamp, 1990). Situational factors include among others meal preparation, consumption situation, consumption appropriateness, location and environment (Bernués, Olaizola, & Corcoran, 2003; Furst *et al.*, 1996; Grunert, 1996; Köster, 2009). Context, the broader environments influencing food choice decisions, include both social environments and physical environments in the food choice process model (Sobal & Bisogni, 2009). In the scope of this doctoral thesis, context is limited to the physical environment in which the consumer tests took place. Nowadays, sensory research is mainly carried out in two different contexts namely central location tests (CLT) such as a laboratory environment, mall test,… and home-use-test (HUT) (Lawless & Heymann, 2010). The potential impact of the context is examined in chapter 6.

The focus of this PhD lies in the determination of consumers' food experience with the aim to obtain a better understanding of what might thrive consumers' food choice. The assessment of subjective product quality and product evoked emotions, both components of the food experience, is therefore crucial and will be discussed more into detail in the following sections.

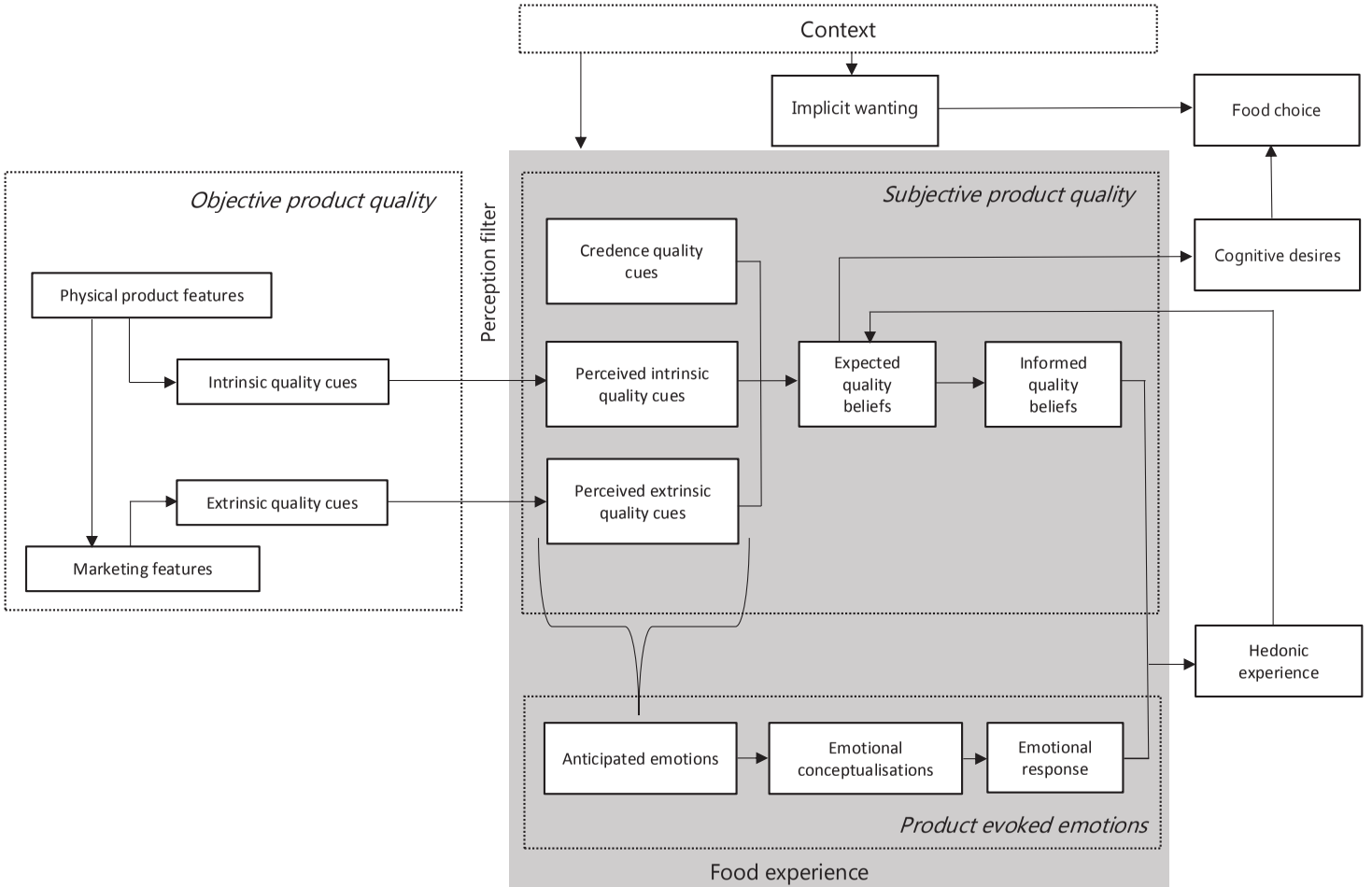

Figure 1.9 Conceptual framework (Grunert, 1996; Gutjar, Dalenberg, et al., 2015; Oude Ophuis & Van Trijp, 1995; Pool, Sennwald, Delplanque, Brosch, & Sander, 2016; Sobal & Bisogni, 2009; Steenkamp, 1990; Thomson & Crocker, 2015)

1.3.5.2. Quality perception process

The quality perception process illustrates how the overall experienced quality (and hence also food choice) is influenced by the human perception of the objective product quality (Grunert, 1996). It is possible to distinguish two connected parts in the quality perception process which are separated by the perception filter (Risvik, 2001): (i) the objective product quality and (ii) subjective product quality.

It all starts with the **physical product features** which make the **intrinsic quality cues.** These intrinsic quality cues or sensory attributes (e.g. colour, shape, texture, aroma) can be determined with the help of instrumental measurements (Oude Ophuis & Van Trijp, 1995). Based upon the physical product features, food companies will determine certain **marketing features** which will cover the **extrinsic quality cues** like price, brand and package (Oude Ophuis & Van Trijp, 1995).

Once humans evaluate food products, their judgements are not only influenced by the objective product quality cues but also by psychological aspects like their beliefs and attitudes (Grunert, 1996). Three key components are determinants of the subjective product quality : (i) **perceived intrinsic quality cues**, (ii) **perceived extrinsic quality cues** and (iii) **credence quality cues.** Based on the perception of these three types of quality cues, consumers will create certain quality *expectations* of the food product. The importance of expectations, given their role in motive fulfilment, has also been highlighted in section 1.3.4. When consumption takes place, consumers will be able to actually *experience* the quality. The experienced quality will effect consumer behaviour which influences food choice (Costa & Jongen, 2006).

The three case studies presented in this PhD provide information linked to the three quality cues. Health-related information (chapter 4) such as a 'light label' is a typical credence quality cue. The experiment with content information (chapter 5) is related to the physical product features which determine the intrinsic quality cues. Lastly, brands are a typical marketing feature thus the experiment with information about yogurt brands (chapter 6) involved extrinsic quality cues.

As this doctoral research wants to examine the influence of information on the sensory evaluation of food products, it is important to notice the differences between the perceived quality cues, expected quality beliefs and informed quality beliefs. Typically, one include measurements of three different conditions to examine the influence of extrinsic and credence (information) cues on the sensory perception: (i) blind, (ii) expected and (iii) informed condition (Cardello, 2007). The blind, expected and informed conditions corresponds with respectively **perceived intrinsic quality cues**, **expected quality beliefs** and **informed quality beliefs** in the proposed conceptual framework of this PhD.

Four main **psychological theories** have been established to explain the **effects** of **expectations** on the experienced food quality (Deliza & MacFie, 1996). A schematic design on how expectations influences food choice and evaluation is provided in Figure 1.10. The

assimilation (or cognitive dissonance) theory stipulates that consumers adjust their perception of the product to the expected quality. Of the four theories, the assimilation effect has been most reported for studies examining the influence of extrinsic cues on the hedonic liking of food products (Cardello, 2007). The *contrast* theory specifies that a person, as a result of the discrepancy between the expected and informed evaluation, will magnify the difference between both measurements. This results in ratings tending to shift in the opposite direction instead. The *generalised negativity* theory applies when products are always negatively evaluated because the expectations were not met. The *assimilation / contrast* theory takes the size of the discrepancy between the expected and experienced evaluation into account. When the discrepancy is relatively small, this theory suggests that it is likely that an assimilation effect will occur. However, if the discrepancy between what was expected and experienced becomes too large, a contrast effect may be observed instead.

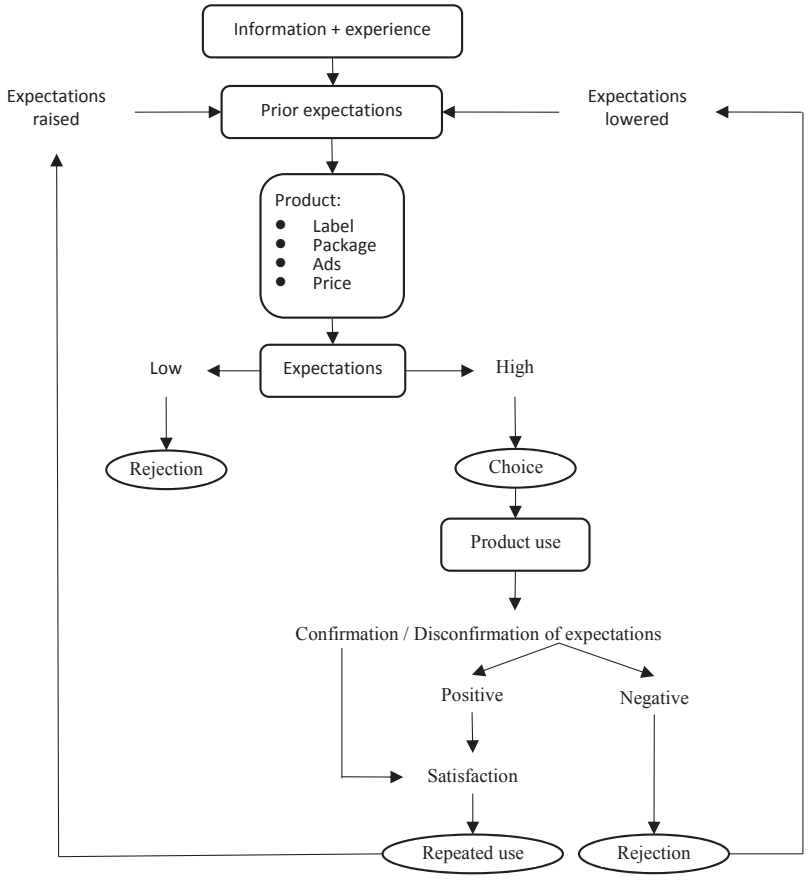

Figure 1.10 Schematic model illustrating the effects of expectations on product selection and evaluation (Deliza & MacFie, 1996)

In the field of sensory science, product quality is by consumers primordially assessed by determining the hedonic value (Lawless & Heymann, 2010; Meiselman, 2013). This is traditionally performed by asking consumers to indicate their **overall liking** on a 9-point scale after tasting a sample (Figure 1.11). Although liking consists on an *implicit* and *explicit* level, as mentioned in 1.3.4., there is a lack on validated methods to measure implicit liking of individuals regarding food products (Köster, 2009; Pool *et al.*, 2016). Therefore, studies included this doctoral thesis opted to work with an explicit method.

Please take a bite of sample 351 and indicate your overall opinion about this sample.

Dislike extremely	Dislike very much	Dislike moderately	Dislike slightly	Neither dislike nor like	Like slightly	Like moderately	Like very much	Like extremely
1	2	3	4	5	6	7	8	9

Figure 1.11 Example of 9-point hedonic scale to assess an individual's explicit liking of a food product

This doctoral thesis goes a step beyond the traditional assessment of the overall liking by also including measurements of the specific sensory attributes to get a better overview on how consumers assess food product quality. In the field of sensory analysis, sensory description of products is traditionally performed by assessors which have been intensively trained for the sensory characterisation of products (Lawless & Heymann, 2010; Meilgaard *et al.*, 2006). However, several **sensory profiling techniques** have been developed the last decade to work with consumers instead of trained assessors as it is accepted that consumers are able to accurately describe products (Ares *et al.*, 2015; Moussaoui & Varela, 2010; Varela & Ares, 2012; Worch, Lê, & Punter, 2010). These sensory profiling techniques can be classified in three categories: (i) verbal-based methods (e.g. flash profile, check-all-that-apply,…), (ii) similarity-based methods (e.g. free sorting task, projective mapping aka Napping®,…) and (iii) reference-based methods (e.g. polarised sensory positioning, pivot profile,…) (Valentin *et al.*, 2012). Of these three categories, the verbal-based methods have been most widely applied the last couple of years in the sensory science.

Given the need for consumer-friendly methods, the use of the **check-all-that-apply** (often abbreviated as CATA) is especially of interest as it is simple, requires little (cognitive) effort and time of participants. Consumers are provided with a list of sensory attributes and are asked to check all applicable terms during a CATA question. An example of such CATA question for pudding is shown in Figure 1.12. Crucial in CATA questions is the selection of terms included in this task. Sensory terms are obtained from trained assessors or based upon previous focus groups or consumer studies with the focal product (Varela & Ares, 2012).

Please check all the words you think apply to sample 241.

☐	Sweet	☐	Bitter
☐	Smooth	☐	Dark
☐	Thick	☐	Milky flavour
☐	Acid	☐	Rough
☐	Creamy	☐	Off-flavour

Figure 1.12 Example of a CATA ballot for pudding (based upon Varela & Ares (2012))

The major disadvantage of the CATA method is that it does not provide any information about the perceived intensity of the evaluated product as only qualitative data is gathered. As a results, CATA has a smaller discriminative capacity than ranking or intensity scales (Dooley, Lee, & Meullenet, 2010). This might be a problem when there are for instance only subtle differences between the tested products. Therefore, a variant of the CATA has been suggested by also asking respondents to indicate the intensity of the applicable sensory attributes (Ares *et al.*, 2014; Reinbach, Giacalone, Ribeiro, Bredie, & Frøst, 2014). This response format is better known under the name **rate-all-that-apply** (RATA) (Ares *et al.*, 2014). An example of a sensory profiling ballot using the RATA response format is provided in Figure 1.13.

Please rate the intensity of all the words you find applicable to sample 514.

	Slightly applicable				Very applicable
Acid	1	2	3	4	5
Aftertaste	1	2	3	4	5
Bitter	1	2	3	4	5
Creamy	1	2	3	4	5
Dark	1	2	3	4	5
Milky flavour	1	2	3	4	5
Off-flavour	1	2	3	4	5
Rough	1	2	3	4	5
Smooth	1	2	3	4	5
Sweet	1	2	3	4	5
Thick	1	2	3	4	5

Figure 1.13 Example of a RATA ballot for pudding

Given that there are numerous novel methods, the reader is referred to the books 'Rapid sensory profiling techniques, 1st edition' (Delarue, Lawlor, & Rogeaux, 2015) and 'Novel techniques in sensory characterisation and consumer profiling' (Varela & Ares, 2014) for an in depth overview as this is beyond the scope of this doctoral thesis.

1.3.5.3. Product evoked emotions

As mentioned previously, consumer's **food choice** is not only **driven** by the overall quality perception but also by the **emotional response** of consumers (Jiang *et al.*, 2014). Perceived intrinsic quality cues, combined with perceived extrinsic quality cues and / or credence quality cues, will lead to the anticipated emotions of food products. Anticipated emotions are seen in this conceptual framework as emotions which consumers expect to endure when consuming the food product. Studies have illustrated that anticipated emotions can be linked to consumer behaviour and even mediate within a healthy food consumption context (Hur & Jang, 2015; Macht & Dettmer, 2006). Anticipated emotions will influence the emotional conceptualisations which are mainly related to the object. The emotional response on the other hand, is highly dependent on the mood of the subject and is more fluent than emotional conceptualisations (Thomson & Crocker, 2015).

During the last couple of years, several studies have examined the emotional conceptualisations consumers experience while consuming food products (Jiang *et al.*, 2014; Köster & Mojet, 2015). In general, this is performed by **verbal self-report methods** using a list containing several emotional terms (Gutjar, Dalenberg*, et al.*, 2015). Consumers are instructed to check or rate all the emotions they experience when consuming a product. Thus, the aforementioned methods CATA and RATA can also be applied for the emotional profiling task. Regarding the emotional terms, it is possible to work with a consumer-defined product specific list or use a standardised emotion list such as the EsSense Profile™ (King and Meiselman (2010), Figure 1.14). Emotional profiles can, similar as sensory profiles, be obtained under blind, expected and informed conditions. Three studies have been reported examining the influence of package information on the emotional profiles on food products, namely blackcurrant squashes (Ng, Chaya, & Hort, 2013b), breakfast drinks (Gutjar, Dalenberg*, et al.*, 2015) and hazelnut / cocoa spreads (Spinelli, Masi, Zoboli, Prescott, & Monteleone, 2015).

Please taste (product name) #xxx now.

Please select the words which describe how you **FEEL RIGHT NOW**. *Select all that apply.*

☐ Active	☐ Glad	☐ Pleasant
☐ Adventurous	☐ Good	☐ Polite
☐ Affectionate	☐ Good-natured	☐ Quiet
☐ Aggressive	☐ Guilty	☐ Satisfied
☐ Bored	☐ Happy	☐ Secure
☐ Calm	☐ Interested	☐ Steady
☐ Daring	☐ Joyful	☐ Tame
☐ Disgusted	☐ Loving	☐ Tender
☐ Eager	☐ Merry	☐ Understanding
☐ Energetic	☐ Mild	☐ Warm
☐ Enthusiastic	☐ Nostalgic	☐ Whole

Figure 1.14 EsSense Profile™ ballot using check-all-that-apply response format (King and Meiselman, 2010)

While several studies examined the emotional conceptualisations of food products during the last couple of years, it is less easy to investigate **emotional response**. This is reflected in the **low number** of **studies** working with **implicit emotion measurement techniques** in the field of food science (Mojet *et al.*, 2015). One of the possible reasons might be that the emotional reaction is rather short and transient which makes it hard to really measure the emotional response (Thomson & Crocker, 2014). Also, the fact that the emotional response is both conscious and unconscious makes it impossible to work with only self-reported measurements techniques (Köster & Mojet, 2015). Further, neuro-imaging technology is nowadays standing in its infancy which leads to technical difficulties when actually consuming food products (Mojet *et al.*, 2015) and there is still little known to fully understand emotional measurements obtained by neuro-imaging techniques like EEG and fMRI during multisensory research (Klasen, Kreifelts, Chen, Seubert, & Mathiak, 2014). Therefore, only emotional conceptualisations obtained by explicit self-reported measurements are implemented in the studies incorporated in this doctoral thesis.

1.4. Structure of the doctoral thesis

This doctoral dissertation is a compilation of papers which have been accepted, published in or submitted to international peer-reviewed journals. A graphical summarization of the structure of this doctoral thesis is provided in Figure 1.15.

Part I provides a **general introduction** to this doctoral thesis. It contains also a more theoretical underpinning of the relevant scientific theories applied during this PhD which leads to a proposed conceptual framework. Further, the research objectives and subsequent research questions are discussed. Also, this part elucidates the relevance of this doctoral research on both scientific and practical level. Lastly, the first part also provides a brief overview of the research designs and the thesis outline.

Part II compiles papers regarding the **development and validation of the EmoSensory® Wheel**, the first research objective of this doctoral thesis. Chapter 2 commences with a brief overview of current methods for the profiling of food products after which the development of the EmoSensory® Wheel is discussed. Further, three experiments related to the discriminatory ability of this methods are included in this third chapter. Chapter 3 compares the performance of the EmoSensory® wheel with a traditional questionnaire format in order to examine the convergent validity. Also, a study is included in this third chapter regarding the use of different response formats (CATA vs. RATA) to further examine the methodological possibilities of this method. Lastly, the fourth chapter further studies if the inclusion of the EmoSensory® Wheel task impacts the concurrent hedonic assessment of food products.

Part III examines the **influence** of specific **information cues** on **consumers' food experience**. Three relevant case-studies were undertaken in order to examine the second research objective. Chapter 4 investigates if the use of a health-related label influences the evaluation of Gouda cheese. Content information was the cue applied in the case-study presented in chapter 5. This sixth chapter examines the influence of such labelling on the emotional and sensory profiling of insect-, plant- and meat-based burgers. Chapter 6 examined the influence of the brand on the EmoSensory® profiling of 5 yoghurt products. Tests included in chapter 6 were conducted not only in the sensory laboratory but also as home-use-tests which makes it possible to explore if the context influences the profiling task.

Finally, the last **part IV** covers a more **general discussion** about the research findings and provides an overview of the overall conclusions. Conclusions, implications, recommendations from the different research parts are tied together in this part. Further, some perspectives for future research are formulated.

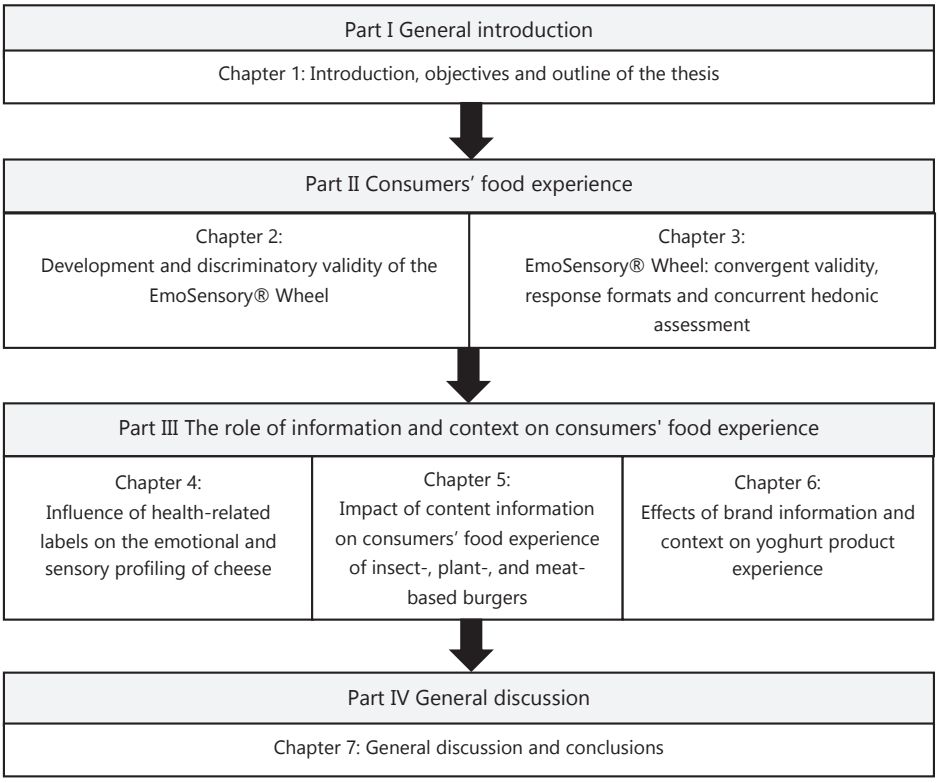

Figure 1.15 Thesis outline

1.5. Research objectives and hypotheses

The overall objective of this doctoral thesis is to examine the influence of information and context on consumers' food product experience. Obtaining a better understanding of this offers a broader view on what thrives consumers' food product evaluation which is of importance to understand food choice. These insights are not only of importance for scientific purpose, it also contains interesting information that can be of benefit for the food industry when applying sensory analysis in the scope of product development or product reformulation.

In accordance with the conceptual framework discussed above (section 1.4.), two main research objectives are distinguished. These research objectives are corresponding to the two main parts of this doctoral thesis. Based upon these two research objectives, 6 hypotheses are formulated in this doctoral thesis. This fifth section discusses the research objectives and hypotheses more into detail.

Part II: Consumers' food product experience

Research objective 1: Development and validation of the EmoSensory® Wheel

The first research chapters (chapter 2 and 3) of this doctoral thesis look into how emotional and sensory profiling of food products can be conducted by using of a new newly developed method, the EmoSensory® Wheel. This new method is introduced in the second part and the main focus lies on the **validation** of the method in part II.

Thomson *et al.* (2010) and Ng *et al.* (2013b) advocated that more research is needed on the crosslinks of sensory and emotional profiling in order to obtain a better understanding of how food products perform. But combining emotional and sensory profiling requires time-enduring tasks which may lead to less reliable results due to respondents' fatigue or satisfying answering strategies (Jaeger, Cardello, & Schutz, 2013). Therefore, it is essential to have a consumer-friendly method for the concurrent elicitation of both concepts. As a consequence, the EmoSensory® wheel was developed. This method is a computerized questionnaire using a wheel-format and its development is discussed in chapter 2.

However, it is crucial to assess the validity of this new method. The validity is the degree to which an instrument accurately measures what it is supposed to measure (Carmines & Zeller, 1979). Three types of validity were evaluated in part II:

- Discriminant validity (Churchill Jr, 1979): examination of the EmoSensory® Wheel is able to discriminate between different products regarding their emotional and sensory profiles.
- Convergent validity (Churchill Jr, 1979): assessing if the EmoSensory® Wheel generates similar emotional and sensory profiles as a list-based questionnaire format.

- Face validity (Nevo, 1985): evaluation of the EmoSensory® Wheel is an adequate method for the emotional and sensory profiling of food products according to consumers.

First of all, it is necessary to know if it is possible to differentiate food products from similar and different product categories based upon the emotional and sensory profiles obtained by the EmoSensory® Wheel. It has no purpose to use this method if it is not able to detect differences in emotional and sensory profiling between food products. Therefore, the **discriminant validity** (Churchill Jr, 1979) of this measuring method was assessed with a range of food products (cola, crisps, chocolate, milk desserts and burgers) as discussed in chapter 2. While the RATA scale has been applied in all studies to examine the discriminant validity of the EmoSensory® Wheel presented in the second chapter, questions arise if also the check-all-that-apply scale (CATA) could be used as the latter has been widely applied for both sensory and emotional profiling (Jaeger & Ares, 2014; Jaeger *et al.*, 2015; Jiang *et al.*, 2014; King & Meiselman, 2010). Accordingly, the first hypothesis states:

H1: The application of the EmoSensory® Wheel by consumers enables discriminating and sensory profiles of food products.

However, the question arises to which extent this method leads to comparable results with a traditional list-based questionnaire format (**convergent validity,** Churchill Jr (1979)). When a new method is proposed, it is obvious to examine to which extent it delivers similar results to those obtained from a traditional method. Therefore, within-subjects experiments were set up to compare the performance of the EmoSensory® Wheel with a traditional questionnaire format, targeting two product categories: chocolate and yogurt. Which is why the following hypothesis is formulated:

H2: Consumers' emotional and sensory profiles of food products obtained by the EmoSensory® Wheel and list-based question format are equal.

Further, one could question to which extent consumers find the EmoSensory® Wheel an appropriate method for conducting the emotional and sensory profiling task. This is related to the **face validity** (Nevo, 1985) of this measuring instrument by asking consumers to which extent the method is adequately able to measure the emotional conceptualisations and the sensory attributes of the products. Although face validity is important, it is often not included in the development of new measuring methods in consumer research (Hardesty & Bearden, 2004). The face validity was measured of both the EmoSensory® Wheel and list-based questionnaire for the two different product categories, namely chocolate and yogurt, to make a comparison of the face validity between these two questionnaire formats possible. Therefore, the third hypothesis states:

H3: Consumers find the EmoSensory® Wheel at least as adequate as the list-based questionnaire format to perform the emotional and sensory profiling task.

In order to determine consumers' food experience, also measurements on the hedonic acceptance are included in the studies described in this doctoral thesis. The hedonic acceptance is traditionally the most-used measurement in the field of sensory science (Lawless & Heymann, 2010). Although it is known that emotional (King, Meiselman, & Carr, 2013) and sensory profiling (Jaeger & Ares, 2015) does not bias the **concurrent hedonic assessment**, it is unclear if this is also the case when the task is performed with the EmoSensory® Wheel which also needs further investigation. Based upon this, the following hypothesis is stated:

H4: The EmoSensory® profiling task does not influence the concurrent hedonic assessment.

Part III: The role of information and context on consumers' product experience

Research objective 2: Understanding to which information and context might influence product experience

While the second part has a methodological angle (development and validation of the EmoSensory® Wheel), the third part of this doctoral thesis delves deeper into the role of expectations on consumers' product experience and also examines the influence of the context. Particular attention is given to the role of expected quality cues and contextual factors.

Consumers are often led by extrinsic cues for their food purchase, as illustrated by the Total Food Quality Model (Grunert, 1996) which indicates that a repurchase of the products is influenced by their evaluation of the sensory attributes. Jiang *et al.* (2014) stipulates how sensory properties might influence emotional responses through the consumption of food products. Therefore, it is interesting to know which sensory properties are linked to emotional conceptualisations and to which extent extrinsic cues might influence these linkages. Research using whole packages indicated that emotional profiles are mainly driven by the sensory properties rather than the package (Gutjar, Dalenberg*, et al.*, 2015; Ng *et al.*, 2013b). However, a package contains a lot of information (e.g. claims, brand, content,…) but literature about the potential impact of specific cues is rather scarce. Therefore, three case-studies were carried out to examine the role of respectively health-related labels (chapter 4), content information (chapter 5) and brand logo (chapter 6) on consumers' food experience. Building upon the findings of Liem, Toraman Aydin, and Zandstra (2012), Ng *et al.* (2013b), Caparros Megido *et al.* (2014) and Gutjar, Dalenberg*, et al.* (2015), the following hypotheses are raised:

H5a: The presence of health-related labels generates a more positive emotional profiling and impacts sensory profiling.
H5b: Emotion and sensory profiles are to a larger extent influenced by information about containing ingredients made from insects compared to information about plant-based and meat-based ingredients.
H5c: The provision of premium brand information results in a more positive consumers' emotional profiling compared to the blind evaluation.

Sensory tests carried out for scientific or industry purposes mostly take place in a controlled laboratory environment (Lawless & Heymann, 2010). Although this makes it possible to perform tests in a standardized way, thereby eliminating as much as possible environmental factors which could influence both the sample (e.g. temperature, humidity, light,...) and evaluation (e.g. influence of other participants,...), this resembles hardly a realistic consumption evaluation. As such, laboratory based testing could arise questions about the validity of the obtained results (Köster, 2003; Meiselman, 2013). Several studies reported that the eating location influenced the evaluation of food products (Boutrolle *et al.*, 2007; Edwards *et al.*, 2003). A similar context effect has also been established when consumers are asked to self-report emotional conceptualisations while imagining a specific consumption context (Piqueras-Fiszman & Jaeger, 2014a, 2014b). Given that consumers tend to be more cognitively involved when performing sensory evaluation at a sensory laboratory (Boutrolle *et al.*, 2007), the fifth hypothesis stipulates:

H6: Consuming food within a lab context leads to more discriminating emotional and sensory profiles compared to evaluation at home.

1.6. Intended scientific and practical contribution

The major research contribution of this doctoral thesis is the use of both emotional and sensory profiling by consumers (in a methodological novel way) in order to have a broader view on consumers' food experience. Indeed, this is the first time both tasks are conducted by the same participants and that connections between emotional conceptualisations and sensory profiling are studied. Further, by applying the method to three case studies, more insights on the influence of specific information cues (health-related labels, content and brand) on consumers' food experience is gathered. The following sections discusses more into detail the intended scientific (section 1.5.1.) and practical (section 1.5.2.) contribution of this thesis.

1.6.1. Scientific contribution

Part II of this doctoral thesis focuses on the development and validation of a wheel-based method to conduct sensory and emotional profiling with consumers, which is a major innovative methodological contribution in the field of sensory science. This new method, the EmoSensory® wheel, is of interest as consumers tend to perceive the emotional profile task sometimes as tedious when using a traditional questionnaire format (Jaeger *et al.*, 2013).

In Part III, three case studies were performed to examine on the one hand the influence of information on the emotional and sensory profiling and on the other hand the potential effect of the context. While expectations research on the influence of information on consumers evaluation is mainly limited to hedonic measurements (Cardello, 2007; Fernqvist & Ekelund, 2014), recently some studies also included emotional measurements when working with package as information (Gutjar, Dalenberg*, et al.*, 2015; Ng *et al.*, 2013b; Spinelli *et al.*, 2015). Therefore, the idea is to contribute on the empirical side of expectations theory by combining both emotional and sensory profiling which makes it possible to examine crosslinks between emotional conceptualisations and sensory attributes. Given that the previously mentioned studies all worked with the whole package, a knowledge gap exist about the influence of specific cues like brand on the emotional profiling let alone sensory profiling.
Further, sensory evaluations of food products always need to take place at a certain place which is in general a sensory laboratory for scientific studies (Lawless & Heymann, 2010). It is known that the potential impact of the evaluation context on the hedonic evaluation differs depending on the product category (Boutrolle, Arranz, Rogeaux, & Delarue, 2005; Boutrolle *et al.*, 2007). Also, imagining different consumption settings (thus working with an imaginary context) could influence the emotional profiling task (Piqueras-Fiszman & Jaeger, 2014a, 2014b). However, there is little known if the actual location influences emotional and sensory profiling of food products. Therefore, the current knowledge about context influence is extended by examining the potential impact of two different contexts (namely CLT and HUT) on the sensory and emotional profiling of a food product.

1.6.2. Societal and industry relevance

This PhD dissertation also seeks to be of practical relevance for policy makers (health and agriculture) and food industry. It illustrates the added value of incorporating emotional and sensory profiling by consumers in order to obtain a better understanding of consumers' food choice. The more practical contributions for are situated on two levels: (i) food product development and (ii) marketing.

Firstly, the assessment of both the emotional and sensory profiles might offer new insights in what really thrives a consumer to accept and even choose a certain food product. As consumer-led food product development is seen as essential for innovation and eventually to stay in business (MacFie, 2007), obtaining such emotional and sensory profiles might be of particular interest of food companies. That is why the development and validation of the EmoSensory® wheel, a consumer-friendly method to obtain emotional and sensory profiles, might be crucial for improving consumer-led food product development. Also, the emotional and sensory profiling might help to ensure that both intrinsic and extrinsic product cues are congruent in, the so-called SensoEmotional optimization (Thomson, 2007), in order to strengthen consumer's product experience.

Secondly, we examine in the second part of this PhD the role of information cues on the food experience. Those cues are broadly the result of marketing based upon the physical properties of the product. When the emotional and sensory profiles of the food products by consumers are obtained, it is possible to have a more effectively marketing based upon these profiles. Not only are these profiles of large importance for the food industry, also policy makers can benefit from them, for instance, when aiming to promote nutritionally-balanced food products. In order to do so, it is interesting to know how consumers perceive certain health-related labels such as 'light' or 'reduced in salt' as discussed in an experiment with cheese (chapter 4). Further, the examination of the context influence (CLT vs. HUT) on consumers' food product experience yields information to which extent measurements obtained in a more standardized setting are comparable to when testing occur in a more realistic situation. Because most studies are nowadays conducted in a laboratory environment, it is of importance to know if those results reflect consumers' opinions compared to a more realistic home use context.

1.7. Research design

Data required to meet the research objectives and to investigate the research questions are collected through quantitative research procedures. Although data is gathered mainly through primary resources, the selection of the emotional and sensory terms used in the EmoSensory® Wheel is based upon a master list composed from secondary data resources. Table 1.2. provides a brief overview of the data sources from the different studies conducted in the scope of this doctoral thesis. The present section is mainly limited to a summarization of the conducted studies as a more detailed description of the different study samples and methodologies applied is included in the methods section of the subsequent research chapters (chapter 2-6).

The main methodology which deserves attention is the selection of the sensory and emotional terms which were used for the assessment of consumers' food experience in this doctoral research. Sensory and emotional terms were selected through a similar two-step procedure during each study following previous research (Ares *et al.*, 2014; Jaeger & Ares, 2015; Jiang *et al.*, 2014; Ng *et al.*, 2013a). The first step consists of composing a master list containing terms from previous research (secondary resources). This master list was then evaluated by a small group consumers who selected all the terms they found applicable when evaluating food products during the second step. These consumers also had the opportunity to add additional terms. Based on the results obtained from these consumers, a final selection was made using pre-defined criteria which also have been applied in other studies e.g frequency of term selection, ability to discriminate between products.

Table 1.2 Data sources

Data source	Primary	
	Qualitative	Quantitative
	Selection terms	Consumer study
Part II		
Chapter 2		
Study 1	n = 25	n = 130
Study 2	n = 25	n = 95
Study 3	n = 25	n = 132
Chapter 3		
Study 1a	n = 20	n = 50
Study 1b	n = 20	n = 50
Study 2a	n = 20	n = 117
Study 2b	n = 20	n = 105
Study 3a	n = 20	n = 176
Study 3b	n = 20	n = 164
Part III		
Chapter 4	n = 20	n = 129
Chapter 5	n = 25	n = 95
Chapter 6	n = 20	n = 99

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Part II

Consumers' food experience

Chapter 2

Development and discriminatory validity of the EmoSensory® Wheel

This chapter is based on:
Schouteten, J.J., De Steur, H., De Pelsmaeker, S., Lagast, S., De Bourdeaudhuij, I., & Gellynck, X. (2015). An integrated method for the emotional conceptualization and sensory characterization of food products: the EmoSensory® wheel. *Food Research International*, 78, 96-107.

Abstract
Although acceptability is commonly used to examine liking for food products, more studies now emphasize the importance of measuring consumers' conceptualizations, such as emotions for food products. It is also important to identify how consumers perceive the sensory attributes of food products, as illustrated by the increasing involvement of consumers in product characterization. The objective of this chapter is to examine the use of a wheel-format questionnaire, the EmoSensory® Wheel, to obtain both an emotional and sensory profile for food products using a hands-on consumer method. Terms selected were product-specific and the rate-all-that-apply (RATA) approach was used as a scaling technique. Three different experiments demonstrated that the EmoSensory® Wheel could discriminate within and between food product categories. The added value of the RATA approach was illustrated in the sample discrimination for some food products when using the weighted attribute scores for analysis. The method was used in both blind and informed conditions to illustrate its applicability across different experimental designs. In general, the respondents did not find the task tedious when using the wheel-questionnaire format, demonstrating the potential for collecting information in a more facile way. Although further studies with other food products are needed, this chapter shows the potential for using this wheel format to obtain information about consumers' emotional and sensory profiling of food products.

2.1. Introduction

Although determining sensory acceptability (liking) is widely used in marketing and consumer research, high market failure rates for newly launched products demonstrate the need for a broader perspective on consumers' food product experience (Cardello *et al.*, 2012; Thomson, Crocker, & Marketo, 2010). Since measuring sensory appeal of food products is considered insufficient (Desmet & Schifferstein, 2008; King & Meiselman, 2010; Thomson, 2007), recent studies have examined the potential for analysing emotions alongside sensory acceptability (liking) for food products to better understand consumers' food choices (Dalenberg *et al.*, 2014; Köster & Mojet, 2015; Spinelli, Masi, Zoboli, Prescott, & Monteleone, 2015).

Over recent years, a number of approaches for self-reporting of emotions associated with food products have been developed. Most studies use a questionnaire format with a list of emotions that can be checked or rated. The EsSense Profile™ by King and Meiselman (2010), mainly developed on snack products (e.g. chocolate, crackers, ice cream, pizza,…), is currently the most commonly used format within food research and incorporates 39 predominantly positive emotions (Figure 2.1). It has been applied to different food products, such as blackcurrant squashes (Ng, Chaya, & Hort, 2013b), breakfast drinks (Gutjar, de Graaf*, et al.*, 2015) and coffee (Bhumiratana, Adhikari, & Chambers Iv, 2014). There is a standardized, cross-cultural questionnaire which focuses on affective feelings towards odours, i.e. The Universal Geneva Emotion and Odour Scale (UniGEOS) (Ferdenzi *et al.*, 2013). The EsSense profile™ and uniGEOS are standardized questionnaires applicable to all food products. Another approach is to use a product-specific questionnaire based on a consumer-generated lexicon. Consumer-based, product-specific lists have been applied to a wide range of food products, such as fruit salads (Manzocco, Rumignani, & Lagazio, 2013), chocolate (Thomson *et al.*, 2010), hazelnut and cocoa spreads (Spinelli, Masi, Dinnella, Zoboli, & Monteleone, 2014), beer (Chaya *et al.*, 2015), blackcurrant squash (Ng, Chaya, & Hort, 2013a), wine (Ferrarini *et al.*, 2010), coffee (Bhumiratana *et al.*, 2014) and orange juice (Thomson & Crocker, 2014). Other approaches to measure self-reported emotions which have been applied to food products include the use of an animated cartoon character, e.g. PrEmo (Desmet, 2003), and working with full sentences after selecting terms based upon a semiotic approach, e.g. EmoSemio (Spinelli *et al.*, 2014).

While food research increasingly includes emotions alongside overall liking, few studies examining the relationship between food products' emotional profile and their sensory characteristics of food products have been published (Spinelli *et al.*, 2014; Thomson *et al.*, 2010). However, both experiments linked the sensory attributes (measured using the QDA method with a trained panel), with emotional measurements by consumers. In other words, two different measurement methods were applied to two different types of respondents. Ideally, emotions and sensory attributes could be incorporated into the same question format, allowing consumers to evaluate the product through an integrated survey. This would provide researchers and food producers with an overall sensory and emotional evaluation of food

products. Furthermore, using an integrated survey could help to reduce response fatigue, boredom and even provide respondents with a better overview compared with using different format techniques to assess emotional and sensory profiling. Also, temporal dominance of emotions (TDE) have been introduced as a technique in order to measure the dynamics of emotional conceptualisations alongside the Temporal Dominance of Sensation (TDS) method which focuses on the assessment of the temporal evolution of dominant sensory attributes over time (Jager *et al.*, 2014). Although the combined measurement of TDS and TDE results in a richer product characterization as mentioned by the authors, one needs to bear in mind that it focuses only on the most dominant sensory attribute and emotion during a certain time frame which has the disadvantage that it does not provide a full overview of consumers' food product experience.

How much you LIKE or DISLIKE (name of the product)?

Dislike extremely	Dislike very much	Dislike moderately	Dislike slightly	Neither like nor dislike	Like slightly	Like moderately	Like very much	Like extremely
❑	❑	❑	❑	❑	❑	❑	❑	❑

Please taste (product name) # xxx now.

Below you will find words which describe different kinds of moods and feelings.
Using the terms listed, please describe how you ***FEEL RIGHT NOW***. Please rate each feeling.

Feeling	Not at all	Slightly	Moderately	Very	Extremely
Active	1	2	3	4	5
Adventurous	1	2	3	4	5
Affectionate	1	2	3	4	5
Aggressive	1	2	3	4	5
Bored	1	2	3	4	5
Calm	1	2	3	4	5
Daring	1	2	3	4	5
Disgusted	1	2	3	4	5
Eager	1	2	3	4	5
Energetic	1	2	3	4	5
Enthusiastic	1	2	3	4	5
Free	1	2	3	4	5
Friendly	1	2	3	4	5
Glad	1	2	3	4	5
Good	1	2	3	4	5
Good-natured	1	2	3	4	5
Guilty	1	2	3	4	5
Happy	1	2	3	4	5
Interested	1	2	3	4	5
Joyful	1	2	3	4	5
Loving	1	2	3	4	5
Merry	1	2	3	4	5
Mild	1	2	3	4	5
Nostalgic	1	2	3	4	5
Peaceful	1	2	3	4	5
Pleased	1	2	3	4	5
Pleasant	1	2	3	4	5
Polite	1	2	3	4	5
Quiet	1	2	3	4	5
Satisfied	1	2	3	4	5
Secure	1	2	3	4	5
Steady	1	2	3	4	5
Tame	1	2	3	4	5
Tender	1	2	3	4	5
Understanding	1	2	3	4	5
Warm	1	2	3	4	5
Whole	1	2	3	4	5
Wild	1	2	3	4	5
Worried	1	2	3	4	5

Figure 2.1 Consumer ballot of overall acceptability and emotional ratings of the EsSense profile™ (King & Meiselman, 2010)

Meilgaard, Dalgliesh, and Clapperton (1979) introduced the flavour wheel to help panellists describe the flavour of beer. A few years later, the wine aroma wheel was developed by Noble *et al.* (1984). This wheel format has been used for a wide range of product categories, such as cheese (Bérodier *et al.*, 1997) and honeybush (Theron *et al.*, 2014). Although sensory wheels have proven added value for the sensory description of products, they are typically used by trained panellists and the industry to develop standardized terminology (Drake & Civille, 2003). The Genova Emotion wheel (Scherer, 2005) was developed and validated as an instrument to measure emotional reactions to objects, events and situations but has also been applied to consumer products (Sacharin, Schlegel, & Scherer, 2012; Scherer, Shuman, Fontaine, & Soriano, 2013). Consumers are increasingly used in the sensory profiling of food products (Meiselman, 2013; Moussaoui & Varela, 2010; Varela & Ares, 2012). Moreover, it is easier for researchers to use a wheel format for emotional profiling (e.g. GEW) or to quantify sensory descriptors when this type of questionnaire is based on open source software (GEW, Sacharin *et al.* (2012)) or commercial sensory software packages, such as EyeQuestion® (Logic8).

This chapter develops and validates a computerized questionnaire using a wheel format, i.e. the EmoSensory® Wheel, to obtain both a sensory and emotional profile for food products assessed by consumers. The aim of this chapter is to assess both the discriminant validity and ease of use of the EmoSensory® Wheel. First, regarding discriminant validity (Carmines & Zeller, 1979), we examine whether the EmoSensory® Wheel can be used to differentiate food products from similar and different product categories based on their emotional and sensory profile. Second, ease and tediousness of the task is examined to determine how participants experience the use of the EmoSensory® Wheel. The purpose here is to identify whether consumers find this a convenient way to report emotional and sensory characteristics of food products. Three different experiments were conducted. One focused on the discriminant validity between food product categories (crisps, chocolate and cola) and two within food product categories (burgers and vanilla pudding). Moreover, the third experiment used blind and informed conditions for product brand to test whether this information could influence a products' emotional and sensory profile.

2.2. Development of the EmoSensory® Wheel

2.2.1. Selection of emotional and sensory terms

For each food product category, we selected product specific emotions using the two-step procedure by Ng *et al.* (2013a). First, a group of 25 consumers had to evaluate a list of emotions based on previous research (Desmet and Schifferstein (2008), King and Meiselman (2010) and Thomson and Crocker (2013)) using the check-all-that-apply (CATA) approach. Further, consumers had the opportunity to add their own emotional terms (Crocker & Thomson, 2014; Ng *et al.*, 2013a). When several terms had a similar meaning in Dutch (e.g. joyful and enjoyment), the most common word was selected by the researchers in agreement with the consumers (Ferrarini *et al.*, 2010; Manzocco *et al.*, 2013; Ng *et al.*, 2013a). To obtain a final selection, the consumer-generated list of emotional terms was evaluated based on the ability of the selected emotions to discriminate between several food products from the same category and the number of adults selecting an emotion (>15%). This corresponds with previous research (De Pelsmaeker, Schouteten, & Gellynck, 2013; Ferrarini *et al.*, 2010; Manzocco *et al.*, 2013; Ng *et al.*, 2013b; Thomson *et al.*, 2010). The valence of emotion (positive, negative or unclassified) were also taken into account to provide a wider overview of the emotions consumers associate with the samples (Desmet & Schifferstein, 2008; Ng *et al.*, 2013a). Therefore, the same quantity of positive and negative emotions was included in this final selection. To obtain this balance, negative emotions with a lower usage frequency (> 10%) were selected, as suggested by Jiang, King, and Prinyawiwatkul (2014). The consumers categorised emotions as 'positive', 'negative' or, 'unclassified' (Jiang *et al.*, 2014; King & Meiselman, 2010).

A similar approach was used to identify the appropriate sensory terms. First, a list of sensory terms for a product category was constructed based on pilot work and previous research (Ares, Barreiro, Deliza, Giménez, & Gambaro, 2010; Ares *et al.*, 2014; Cruz *et al.*, 2013; Jaeger, Chheang*, et al.*, 2013; Jaeger *et al.*, 2014; Jager *et al.*, 2014). Next, a group of consumers evaluated this list and checked all applicable terms to describe the product samples. Consumers were also able to add their own sensory terms if they thought that the list was incomplete. A selection was made to obtain the final list of sensory terms based on the inclusion criteria, i.e the frequency of use (>15%) and the ability to discriminate between different product samples. In addition, some terms were selected based on their usage frequency in order to cover all multiple sensory modalities (appearance, aroma, flavour/taste, texture, aftertaste) in the sensory evaluation, as suggested by previous research involving sensory characterisation by consumers (Ares *et al.*, 2014; Jaeger & Ares, 2015).

2.2.2. Scaling emotional and sensory terms

While Ares *et al.* (2014) successfully applied the rate-all-that-apply (RATA) scaling method for the sensory characterization of several food products, such as milk desserts and sliced bread, Ng *et al.* (2013a) proposed using the RATA approach for emotions, after comparing the

effectiveness of the CATA methodology for a consumer-defined lexicon with intensity scaling in the EsSense Profile™.

RATA questions have the advantage of using a similar approach to CATA questions and therefore also enable quick and easy data collection from large consumer samples. Moreover, applying RATA questions makes it possible to obtain reliable scores for the intensity of sensory attributes (Ares, Bruzzone, & Giménez, 2011; Husson, Le Dien, & Pagès, 2001; Worch, Lê, & Punter, 2010). It also addresses one of the major limitations of CATA, namely the inclusion, in previous CATA studies, of multiple terms for a single attribute, which vary in intensity (Bruzzone, Ares, & Giménez, 2012; Jaeger, Giacalone*, et al.*, 2013; Lado, Vicente, Manzzioni, & Ares, 2010). This leads to a suboptimal result because of decreased reliability (Jaeger, Chheang*, et al.*, 2013).

As a consequence, the RATA scaling approach was applied for the scaling of both the emotional and sensory terms in our wheel-format question. Consumers rated the intensity of these terms using a 5-point scale with end-point anchors 1 = 'slightly' to 5 = 'extremely', similar to the study by Ares *et al.* (2014).

2.2.3. Number and order of terms

To the authors' knowledge, only three published studies have used RATA questions in sensory research: Reinbach, Giacalone, Ribeiro, Bredie, and Frøst (2014) who measured consumers' evaluation of 38 sensory attributes for eight beers, Ares *et al.* (2014), who used RATA questions to enable participants to evaluate 5-7 products based on 15-18 different sensory terms during a single session and Jaeger and Ares (2015) who examined the potential bias of RATA questions on hedonic liking scores for several food products. Regarding the similar CATA approach, Jaeger *et al.* (2015) concluded that the use of 'short' (10-17 terms) or 'long' (20-28 terms) sensory term lists had limited impact on the sensory product characterizations elicited, although a lower average frequency of selected terms was observed for long lists. Therefore, the authors chose to limit the total number of terms (emotional and sensory) in an EmoSensory® Wheel to thirty.

Both emotional and sensory terms were presented alphabetically (Dutch language) to facilitate response and reduce respondent fatigue (King, Meiselman, & Carr, 2013). Although randomizing the terms within and across participants is recommended to minimize the influence of term order, several previous studies also used alphabetical term order (De Pelsmaeker *et al.*, 2013; Jaeger, Chheang*, et al.*, 2013; King & Meiselman, 2010; Reinbach *et al.*, 2014). Moreover, previous research found similar results when comparing consumers' sensory product characterization using a fixed term order with those obtained using QDA by a trained panel (Ares *et al.*, 2010; Bruzzone *et al.*, 2012; Dooley, Lee, & Meullenet, 2010). Furthermore, research conducted by Ares and Jaeger (2013) on the influence of attribute order on sensory product characterization indicates that this influence is not great enough to invalidate results; the same conclusion applies to emotional terms (King & Meiselman, 2010; King *et al.*, 2013).

2.2.4. The EmoSensory® Wheel

EyeQuestion (Logic8 BV) software (Version 3.12.0) was used to construct the wheel-format questionnaire. This software is used by several academic and research institutions and commercial companies for sensory and consumer research. Respondents can move the wheel by using a computer mouse (Figure 2.2). Respondents first need to click on the applicable emotion / sensory term and are then instructed to rate the intensity using a 5-point scale. This 5-point scale ranges from 1 = 'slightly' to 5 = 'extremely' (Figure 2.3). After rating a term, the term appears in a column next to the wheel and the next term can be selected and rated.

Respondents receive the following instructions about the use of the EmoSensory® Wheel: *'Below you can find an EmoSensory® Wheel. This wheel consists of two parts and contains both emotional and sensory terms. You can use the computer mouse to move the wheel. When clicking on a term, a scale will be shown on which you can rate the intensity of the selected term.'* An example of instructions for burger sample XXX were: *'Please taste burger sample XXX and indicate how much you like the sample. Then, tick on each word that applies to describe burger XXX and rate the intensity. Also, rate the intensity of the words which describe how you feel right now.'* These instructions are similar to those used in consumer research for sensory (Jaeger, Chheang*, et al.*, 2013) and emotional characterization (King & Meiselman, 2010) of food products.

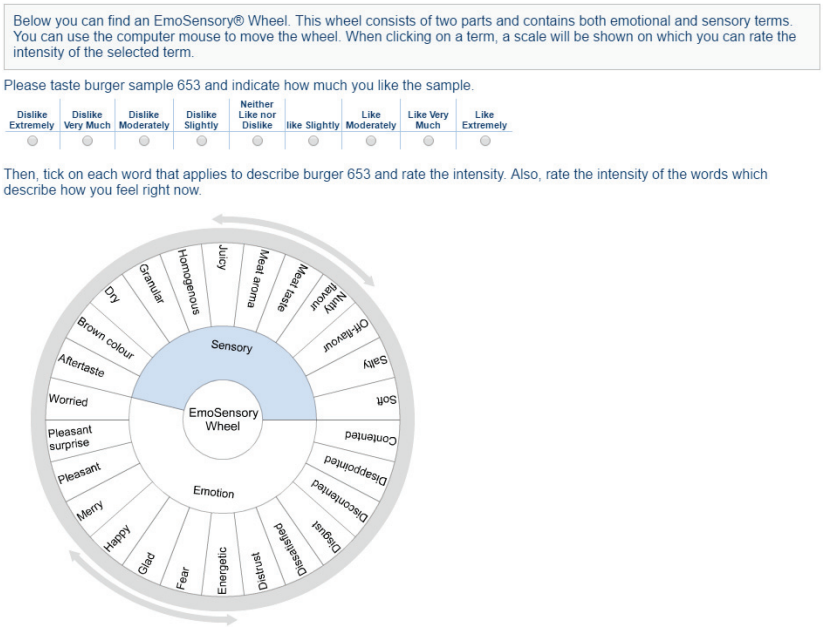

Figure 2.2 Example of panellist screen with instruction of the EmoSensory® Wheel for burgers

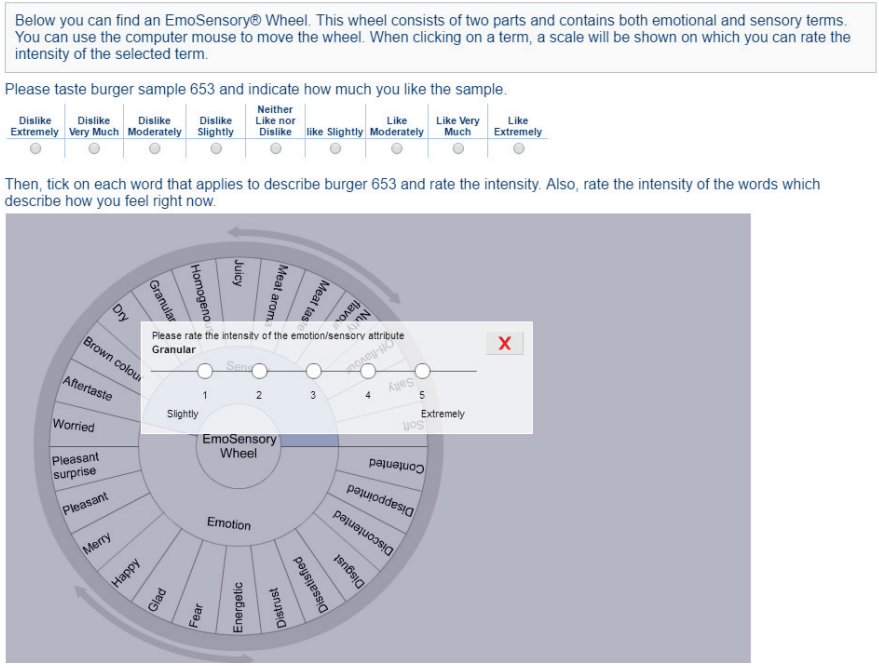

Figure 2.3 Example of the panellist screen for rating an attribute (example: 'Granular') after selecting it using the EmoSensory® Wheel for burgers

2.3. Experimental studies

2.3.1. Experimental design

In total, three experiments are discussed in this chapter.

The first experiment had two objectives. First, the potential for obtaining different emotional profiles with the EmoSensory® Wheel was explored when comparing products from different food categories (cola, chocolate and crisps) at a consumer fair. Second, consumer perceptions on the use of the wheel format were measured.

A second experiment with burgers took place in the sensory facilities at Ghent University. The purpose of this experiment was to examine the use of the EmoSensory® Wheel within one food category in a more standardized, laboratory setting.

Next to this laboratory setting, a third experiment took place at a consumer fair to evaluate the use of the method at a location with a more divergent consumer sample. Here, vanilla pudding was chosen as its sensory and emotional profile normally differs less. The product was tested in both blind and informed conditions.

2.3.2. Materials and methods

2.3.2.1. Participants

Participants were recruited for the first and third experiment during a consumer fair. This enabled a broad sample of consumers to be obtained with different socio-economic characteristics such as age, education level, income and gender and who were unfamiliar with the sensory evaluation of food products. This recruitment approach is common for a study aiming to capture consumer opinions on food products at a central location (Meilgaard, Carr, & Civille, 2006; Stone, Bleibaum, & Thomas, 2012). The consumers were seated in different booths to ensure that they evaluated the products independently (Table 2.1).

Table 2.1 Overview experimental design of three experiments

	Experiment 1	Experiment 2	Experiment 3
Products	Crisps, cola, chocolate	Burgers	Vanilla pudding
Experimental design	Between product categories	Within product category	Within product category
Presentation	Blind	Blind	Blind (B) & informed (I)
Location	Consumer fair	Laboratory setting	Consumer fair
Sample size	130	95	B: 77, I: 65
Mean age	34	25	B: 45, I: 44
Female/male (%)	54.6/45.4	35.8/64.2	B: 63.6 / 36.4 I: 60.0 / 40.0

In total, 130 consumers participated in the first experiment and 54.6% were female. Age ranged from 18 years to 76 years (mean = 34 years; S.D. = 14 years). The second experiment, with burgers, took place in sensory facilities in Belgium. In total, 95 participants were recruited from

a database of people who regularly participate in scientific research tests. No participation fee was provided. The majority of the consumers were male (64.2%). The mean age was 25, with a standard deviation of 12.5 years. More women took part in the pudding test in the third experiment (60.0% in informed conditions, 63.6% in blind conditions) which took also place at a consumer fair. Participants' age was similar across both conditions and ranged from 18 to 79 years.

2.3.2.2. Products and terms

For the first experiment, three products were selected based on a focus group to compare the use of the EmoSensory® Wheel across different food categories: crisps, chocolate and cola. These are all highly acceptable products among Belgian consumers and were chosen as earlier research suggests that emotional intensities could differ while having a comparable, high liking (King & Meiselman, 2010). Also, these high-likeable snack products fit well with the location of the consumer trade fair.

In the next step, the purpose was to examine the use of the wheel format within a food product category. Burgers were chosen for the second experiment as they differ greatly in their sensory properties and are also associated with different types of emotions (Olsen, Røssvoll, Langsrud, & Scholderer, 2014). Burgers are also typically eaten in Belgium as part of a main dish accompanied by (mashed) potatoes and vegetables. Therefore, they are familiar and part of most consumers' regular diet, hence fitting the purpose of testing the use of the EmoSensory® Wheel with a familiar product category. Vanilla pudding was selected for the third experiment as there are limited differences regarding its sensory properties and its association with emotions tends to be lower, based upon previous local tests. Furthermore, it is a dairy product which is widely consumed worldwide (Ares, Baixauli, Sanz, Varela, & Salvador, 2009) and is a source of calcium, several vitamins and minerals (van den Berg *et al.*, 2014). As it is also a similar product to the milk desserts that have been used in the RATA-based experiment of

For both product categories, consumers evaluated three commercially available products. The products were chosen to cover a wide range of sensory variability (Spinelli *et al.*, 2014). Two burgers containing different types of meat and one vegetable-based burger were used in the second experiment. In the third experiment, samples of one private label and two A-brands of vanilla pudding (based on cow's milk) were served. This experiment also included an information treatment (brand information), alongside the commonly used blind conditions, as informed conditions provide a more realistic scenario (Shepherd, Sparks, Bellier, & Raats, 1991; Stolzenbach, Bredie, Christensen, & Byrne, 2013; Varela, Ares, Gimenez, & Gambaro, 2010). The purpose of including an experiment using two different treatments (blind/informed) was to identify whether the method could be applied in either blind or informed conditions, not to examine a potential brand effect. Consumers were randomly assigned to either blind or informed conditions, similar to the study by (Crocker & Thomson, 2014) with a new conceptualization evaluation method and chapters examining brand information effect on the

conceptualization (Thomson & Crocker, 2015) and sensory characterization (Vidal, Barreiro, Gómez, Ares, & Giménez, 2013) of food products.

The number of products was limited to three, which is in line with previous emotion research (King *et al.*, 2013). To allow for comparison between product categories, the same 17 emotional terms were used in the EmoSensory® Wheel for the three samples in the first experiment: 'glad', 'enthusiastic', 'happy', 'good', 'calm', 'nervous', 'unpleasant surprise', 'discontented', 'dissatisfied', 'pleasant', 'guilty', 'disappointed', 'contented', 'sad', 'desire', 'satisfied' and 'disgust'. The sensory terms differed slightly due to the differences in sensory attributes between the products. In the EmoSensory® Wheel for crisps, the sensory terms were: 'off-flavour', 'chips aroma', 'yellow colour', 'smooth', 'hard', 'crunchy', 'light', 'aftertaste', 'tasty', 'fat flavour', 'soft', 'sweet' and 'salty'. The sensory terms for the cola were: 'dark colour', 'cola flavour', 'sparkling', 'artificial flavour', 'sweet', 'cola aroma', 'aftertaste', 'sweet', 'off-flavour', 'sour', 'tasteless', 'soft', 'light' and 'bitter'. Finally, the sensory terms for chocolate were: 'bitter', 'chocolate aroma', 'chocolate flavour', 'smooth', 'hard', 'film formation on the tongue', 'granular', 'aftertaste', 'sticky', 'creamy', 'smooth', 'melting' and 'sweet'. Emotional and sensory terms for both the burgers (experiment 2) and vanilla pudding (experiment 3) were selected based on the procedure described above and are listed in respectively Table 2.2 and Table 2.3.

Table 2.2 Overview emotional and sensory terms used in the EmoSensory® Wheel with burgers

Experiment 2: Burgers	
Emotional terms	Sensory terms
Pleasant surprise^{+}	Brown colour
Worried^{-}	Homogenous
Glad^{+}	Dry
Energetic^{+}	Granular
Happy^{+}	Aftertaste
Discontented^{-}	Nutty flavour
Dissatisfied^{-}	Off-flavour
Pleasant^{+}	Juicy
Disappointed^{-}	Meat aroma
Contented^{+}	Meat taste
Fear^{-}	Soft
Merry^{+}	Salty
Disgust^{-}	
Distrust^{-}	

$^{+,-}$ means positive / negative classified emotion

Table 2.3 Overview emotional and sensory terms used in the EmoSensory® Wheel with vanilla pudding

Experiment 3: Vanilla pudding	
Emotional terms	Sensory terms
Worried^{-}	Off-flavour
Energetic^{+}	Thick
Enthusiastic^{+}	Light colour
Happy^{+}	Milky flavour
Good^{+}	Aftertaste
Calm^{u}	Creamy
Nervous^{-}	Firm
Dissatisfied^{-}	Vanilla aroma
Enjoyment^{+}	Vanilla flavour
Guilty^{-}	Liquid
Disappointed^{-}	Soft
Satisfied^{+}	Sweet
Sad^{-}	Sour
Desire^{+}	
Disgust^{-}	

$^{+,-,u}$ means positive / negative / unclassified emotion

2.3.2.3. Procedure

The first and third experiment took 15 to 20 minutes and consumers were not compensated for their participation. The questionnaire for the second experiment took 20 to 25 minutes to complete.

The computerized questionnaire comprised four parts (figure 3). In the *first part*, several typical *screening questions* were asked, such as product consumption, age (≥ 18 years old) and (food) allergies. The *second*, main *part* of the questionnaire dealt with the *evaluation* of the specific *product*s. Consumers were instructed to consume a small portion of the sample and to indicate its overall acceptability on a 9-point liking scale. Similar to previous research with emotional and sensory terms, respondents were asked about overall acceptability before seeing the EmoSensory® Wheel, (King *et al.*, 2013; Lucak & Delwiche, 2009; Popper, Rosenstock, Schraidt, & Kroll, 2004). Then, the EmoSensory® Wheel was shown to the consumers and they checked and rated the appropriate emotions conceptualizations and sensory attributes after they had consumed the rest of the product sample.

Samples were assigned a computer-generated, random 3-digit code and evaluated in a randomized order following a Williams design, which avoids first-position distortions and possible carry-over effects (MacFie, Bratchell, Greenhoff, & Vallis, 1989). The samples were served using a monadic sequential presentation scheme in transparent plastic containers. Participants received enough to allow 3 bites or sips of the product. The crisps and chocolate samples were served at room temperature, while the cola and vanilla pudding were served at 8°C. The burgers were cooked according to the packet instructions. Under the informed conditions, the brand name was shown to the consumers. A 2 to 3 minute break between each sample was required and participants were instructed to clear their palate with water and unsalted crackers (King & Meiselman, 2010). Consumers' evaluation of each sample took around 2-4 min. After tasting, two 7-point Likert scale questions (1 = 'strongly disagree' and 7

= 'strongly agree') were included to evaluate the use of the EmoSensory® Wheel: (i) it was easy to answer the questions about these samples using the EmoSensory® Wheel; and (ii) it was tedious to answer the questions about these samples using the EmoSensory® Wheel, as derived from Ares *et al.* (2014). These two questions were not included in the second experiment with burgers. Specific statements relating to *consumer behaviour* were included in the *third part*. In the first and third experiment, these questions were related to the frequency of shopping at the main supermarket chains in Belgium and also questions related to the attitudes towards private label products were included derived from Olsen, Menichelli, Meyer, and Naes (2011). Specific statements regarding health, sustainability and taste attitudes of consumers were incorporated in the questionnaire for the burgers during the third part of the questionnaire (Candel, 2001; Cox & Evans, 2008; Lindeman & Väänänen, 2000; Pliner & Hobden, 1992; Roberts, 1996; Roininen & Tuorila, 1999; Steptoe, Pollard, & Wardle, 1995; Vanhonacker, Van Loo, Gellynck, & Verbeke, 2013; Verbeke, 2015). *Finally*, questions regarding *socio-demographic variables* such as age, gender and place of residence were included for classification purposes.

2.3.3. Data analysis

Two approaches can be used to analyse the RATA data (Ares *et al.*, 2014): frequency of selection or weighted frequency of selection (RATA scoring). If an item was selected by a consumer, the points of the scale (ranging from 1 to 5) were allocated to numbers in increasing order. Next, the RATA scores for each emotional and sensory term for each product sample were calculated by summing up these scores, which provides the weighted RATA scoring. Cochran's Q test was carried out to identify significant differences in the frequency of term selection between the products in the experiments. For RATA scoring, Friedman's test was performed to determine significant differences between the three samples in each experiment.

One-way repeated measures analysis of variance (ANOVA) was performed on the liking scores in the second and third experiments to determine whether they differ significantly between the samples of the same product. When Mauchly's test of sphericity showed that no sphericity was present, Greenhouse-Geisser correction was applied.

An independent samples t-test was used to examine whether the liking for each sample significantly differed between the blind and informed conditions in the third experiment. To determine whether the condition influenced the evaluation of each vanilla pudding sample, Fisher's exact test was applied to the frequency of use for each emotional and sensory term. Mann-Whitney U Test has been applied to determine significant differences between both experimental treatments of the vanilla pudding when using the RATA scoring.

Correspondence analysis (CA) was conducted on the total frequency count of emotional or sensory terms for each product in order to identify relationships between the terms and products of experiment 1 and 2.

Principal component analysis (PCA) was performed on the mean intensity ratings of the emotional or sensory terms for each product of experiment 1 and 2.

To assess the relationships between the emotional and sensory profiles, multiple factor analysis (MFA) was performed on the intensity data for the informed pudding samples of experiment 3.

Statistical analyses were performed using IBM SPSS Statistics 22 predictive analytics software except for CA, PCA and MFA which were conducted using XLSTAT Version 2016.03.30882. A 5% significance level ($p \leq 0.05$) was considered for all tests, unless stated otherwise.

2.4. Results

2.4.1. Discriminant validity

2.4.1.1. Experiment 1: crisps, cola and chocolate

The first experiment revealed significant differences for products' associations with emotions for 6 out of 17 terms (Figure 2.4). This underlines that the EmoSensory® Wheel can be applied to obtain discriminating emotional profiles between food product categories when only taking the frequency of selection into account. People mainly selected positive emotional terms. This is in line with other studies and could be explained by the recruitment of actual product consumers for our test, as they tend to be more positive (Desmet & Schifferstein, 2008; King & Meiselman, 2010; Schifferstein & Desmet, 2010). CA was performed on the total frequency counts of the emotional terms for the three samples. Interestingly, the first dimension cannot be defined as linked with the valance of the emotional terms as positively and negatively valenced emotional terms are scattered around the first dimension. Although this is in contrast with results of several previous studies (Gutjar, Dalenberg*, et al.*, 2015; Ng *et al.*, 2013a), this might be due to the fact this first experiment included several product categories while other studies worked with samples of the same product category (e.g. all chocolate samples).

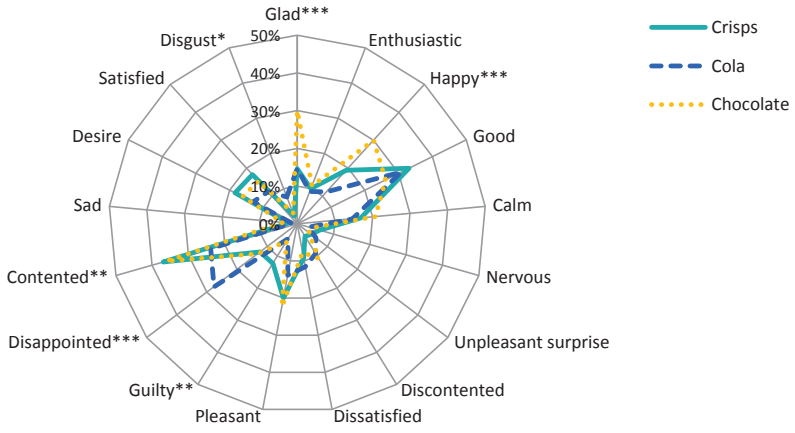

Figure 2.4 Frequencies (in % consumers) of emotional term selection for crisps, cola and chocolate (n=130)
,,*** indicate significant differences in frequency of selection at p ≤0.05, 0.01, 0.001*

In a second analysis, we used the intensities to identify significant differences between emotional profiles for the products. Significant differences were observed for 6 emotional terms: glad, happy, calm, contented, guilty and disappointed. This is less than the study by King and Meiselman (2010) which used a 5-point intensity scale to examine emotional associations with five products (pizza, mashed potatoes and gravy, vanilla ice cream, fried chicken and chocolate). The lower number of significant differences in emotions evoked between the products might be due to the fact that almost half of the emotional terms were negative (8 out

of 17 terms). However, our results support the findings of King and Meiselman (2010) who showed that highly acceptable products could differ in the intensity of their emotional associations. An overview of the results of this first experiment can be found in Table 2.4. Further, the biplot (Figure 2.6) showed differences in the intensity of emotional conceptualisations associated with the several product samples.

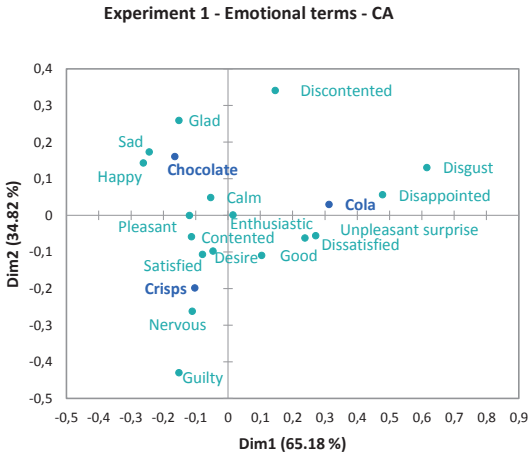

Figure 2.5 CA emotion plot (Dimension 1 vs. Dimension 2) obtained from total frequency counts (n = 130)

Table 2.4 Summary of the results of the first experiment with 3 food product categories (crisps, chocolate, cola) (n=130)

	Crisps	Chocolate	Cola
Mean liking (S.D.)	6.13 (1.44)	6.26 (1.72)	5.38 (1.72)
Emotional terms with significant differences between samples	RATA: contented**, disappointed***, disgust*, glad***, guilty**, happy*** RATA scoring: calm*, contented**, disappointed***, glad***, guilty*, happy***		

*,**,*** indicates significant differences at p ≤ 0.05, p ≤ 0.01, p ≤ 0.001

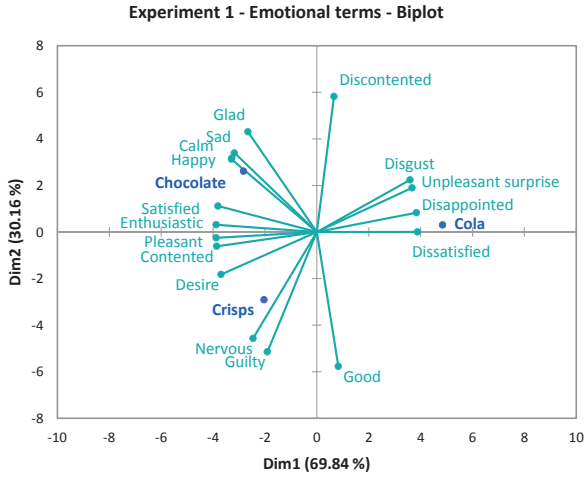

Figure 2.6 Biplot of the emotional terms for the three product categories (n = 130)

2.4.1.2. Experiment 2: burgers

Overall liking for the burgers varied significantly ($F(2, 80{,}816)=78{,}816$, $p< 0.001$) from 3.51 (burger C) to 6.43 (burger A). When only taking the frequency of selection into account, significant differences between the samples were observed for 11 out of 14 emotional terms and for 10 out of 12 sensory terms. Figure 2.7 shows the EmoSensory® profiles and gives an overview of the percentage of consumers who checked a particular emotional or sensory term for a sample. In general, average term selection is higher for most sensory terms compared to emotional terms. The average sensory term selection was comparable to the study by Ares *et al.* (2014). Although the emotional terms are selected less frequently, their frequency is similar to previous CATA studies (Ng *et al.*, 2013a) and accords with an experiment with flavoured milk brands in the same country (De Pelsmaeker *et al.*, 2013). It is important to note that products B and especially C are associated more with negative emotions like disappointed and discontented. Usually, consumers tend to associate food products with positive emotions (Desmet & Schifferstein, 2008; King & Meiselman, 2010; Schifferstein & Desmet, 2010), but apparently this is less so for these two burgers. The higher prevalence of negative emotions could be the result of the rather low liking for these burgers, which would confirm previous research stating that emotions are associated with liking (Cardello *et al.*, 2012; Gutjar, de Graaf, *et al.*, 2015; King, Meiselman, & Carr, 2010; Köster & Mojet, 2015; Spinelli *et al.*, 2015). CA plots based upon the frequency of the emotional (Figure 2.8a) and sensory (Figure 2.8b) show that both plots are rather unidimensional.

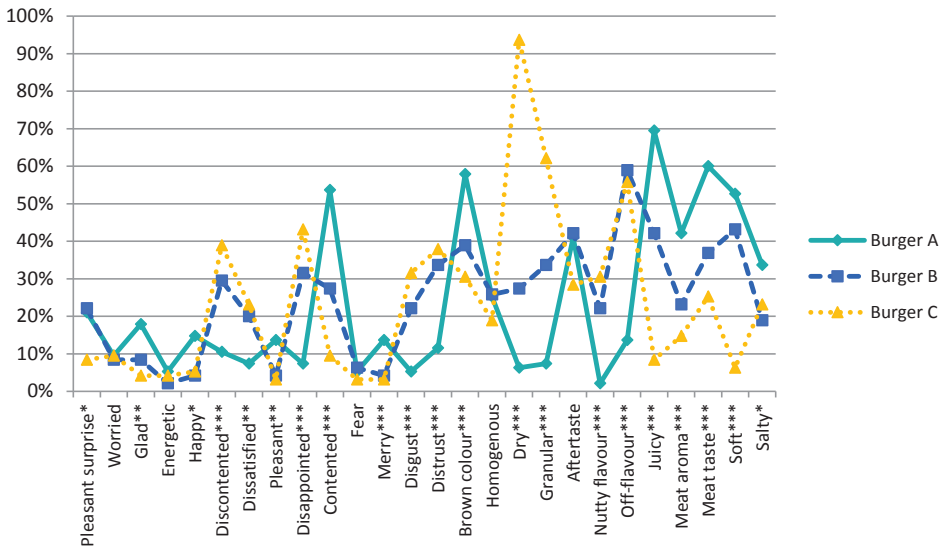

Figure 2.7 Emotional and sensory profile of 3 burgers using the frequency of term selection by the respondents (n=95)
,,*** indicate significant differences at p ≤0.05, 0.01, 0.001*

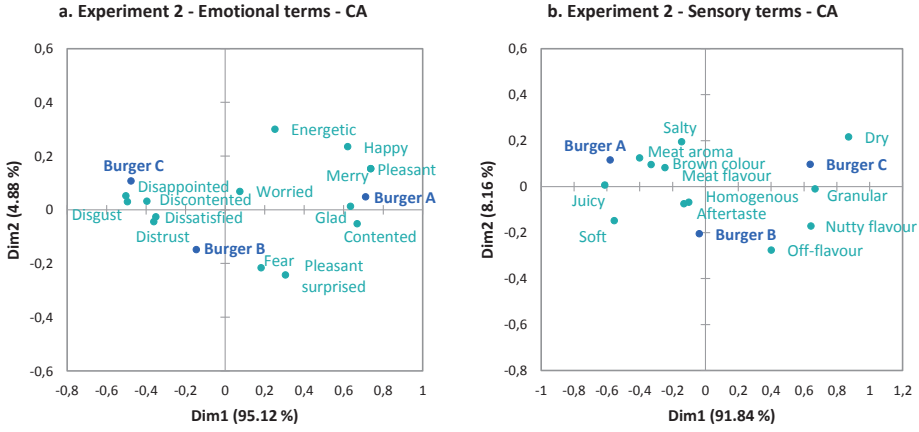

Figure 2.8a,b CA emotion plot (Dimension 1 vs. Dimension 2) obtained from total frequency counts of emotional (a) and sensory (b) term data (n = 95)

When analysing the RATA data as weighted scores, no significant differences for the association with emotions 'fear', 'worried' and 'energetic' and the sensory attribute 'aftertaste' were observed between the samples. Therefore, when compared to the term selection approach, significant differences were observed for one additional sensory term 'homogenous' and mean ranks for burger C are the lowest (Table 2.5). The biplot of the intensities of the emotional terms (Figure 2.9a) showed that the first dimension can be linked to the valence of the emotional conceptualisations as positively valenced emotional terms are positively associated with the first dimension while negatively valenced emotional terms are negatively associated with the first dimension. The biplot based upon the intensities of the sensory terms (Figure 2.9b) found that the burger A was mainly related to 'meat aroma', 'meat flavour', 'juicy' and 'brown colour'. Off-flavour was predominantly reported for burger B while burger C was highly characterised as having a granular texture and nutty flavour.

Table 2.5 Summary of the results of the experiment with burgers (n=95)

	Burger A	Burger B	Burger C
Mean liking (S.D.)	6.43[a] (1.43)	4.75[b] (1.83)	3.51[c] (1.68)
Emotional terms with significant differences between samples	RATA: contented***, disappointed***, discontented***, disgust***, dissatisfied**, distrust***, glad**, happy*, merry**, pleasant**, pleasant surprise* RATA scoring: contented***, disappointed***, discontented***, disgust***, dissatisfied**, distrust***, glad***, happy*, merry**, pleasant***, pleasant surprise*		
Sensory terms with significant differences between samples	RATA: brown colour***, dry***, granular***, juicy***, meat aroma***, meat taste***, nutty flavour***, off-flavour***, salty*, soft*** RATA scoring: brown colour ***, dry***, granular***, juicy***, meat aroma***, meat taste***, homogenous*, nutty flavour***, off-flavour***, salty**, soft***		

[a,b,c] liking of burgers with no common superscripts differ significantly ($p \leq 0.05$)

*,**,*** indicates significant differences at $p \leq 0.05$, $p \leq 0.01$, $p \leq 0.001$

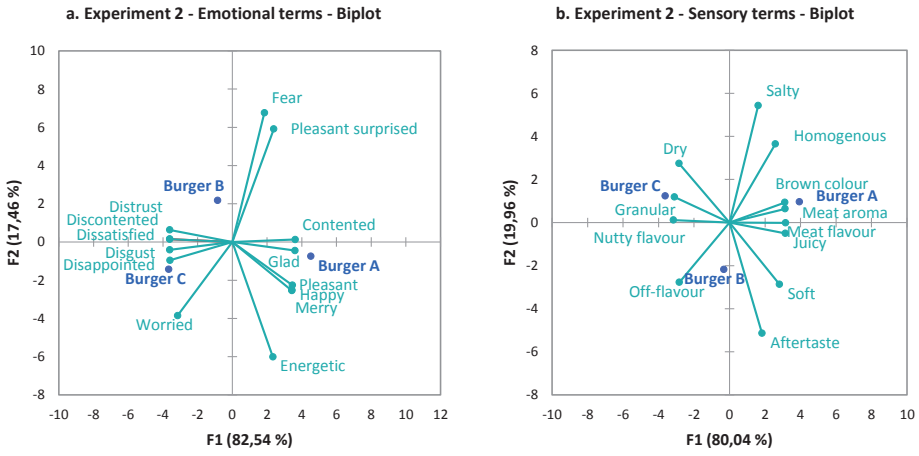

Figure 2.9a,b Biplots of the emotional (a) and sensory terms (b) for the three burger samples in the second experiment (n = 95)

In conclusion, this experiment with burgers showed that the EmoSensory® Wheel can be used to discriminate between different samples of the same food product. The use of RATA to discriminate between the samples for both emotional and sensory terms is also illustrated. Regarding the data analysis for RATA, using weighted attribute scores shows a slight improvement in the number of significantly different terms.

2.4.1.3. Experiment 3: vanilla pudding

No significant differences ($F(2, 4.163) = 2.163$,$p = 0.119$) were found in the overall *blind* liking between the three samples. Although several emotional and sensory terms were often selected by the consumers, term selection was only significantly different between the samples for 4 terms (happy, soft, aftertaste and vanilla flavour) under the blind conditions. However, significant differences for eight emotional (good, enjoyment, disappointed, satisfied, calm, happy, worried and dissatisfied) and eight sensory terms (thick, milk flavour, creamy, firm, vanilla aroma, vanilla flavour, soft and liquid) were found when applying the RATA scoring approach. The difference in the amount of significant differences between both statistical approaches can be explained by the fact that several emotions and sensory terms were similarly applicable to the samples, but that the intensity varied between the samples. This illustrates the added value of the rating approach, compared to the frequency of selection, for the data analysis, as indicated by Ares *et al.* (2014). Moreover, if we assume that using the CATA approach would lead to similar selection frequencies for RATA, this demonstrates that RATA could be a more suitable technique for certain samples compared to CATA, especially when the intensity of terms is the main difference. Furthermore, this result illustrates that the EmoSensory® Wheel can be used to obtain additional information on the emotional and sensory profile for a product when no significant difference in the acceptance between products has been identified.

When providing *information* about the brand, significant differences ($F(2,19.129) = 17.129$, $p < 0.001$) were found in the overall liking between the three samples. Significant differences were found for 5 out of 15 emotional and for 5 out of 13 sensory terms when using the frequency of term selection (Figure 2.10). If the intensity of the terms was taken into account, significant differences were identified for two additional sensory terms (creamy and aftertaste). The percentage of terms with significant differences is similar to the study with milk desserts by Ares *et al.* (2014).

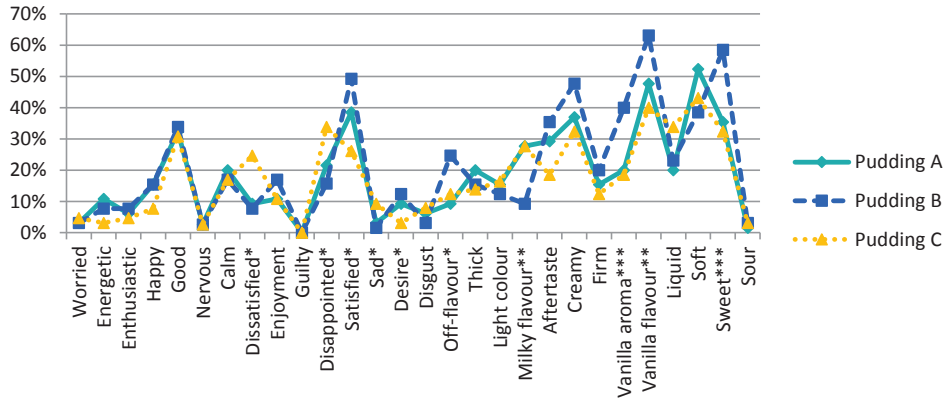

Figure 2.10 Emotional and sensory profiles of 3 types of vanilla pudding using the frequency of term selection by the respondents (n = 65) during an informed (branded) evaluation (n = 65)
,,*** indicate significant differences at p ≤ 0.05, 0.01, 0.001*

Mean liking (measured on a 9-point overall liking scale) differed significantly only for the well-known sample B between the blind (5.95) and informed (6.45) conditions. A previous study with vanilla milk desserts found that information only had a small impact on acceptance scores (Vidal *et al.*, 2013). No significant differences in the *frequency of use* for sensory or emotional terms between the conditions were observed for sample A. Regarding sample B, the sensory term 'soft' was significantly more frequently used under the informed conditions. People linked 'disappointed' and 'sad' significantly more with the store brand sample C under informed conditions compared to blind conditions. When using the data from *RATA scoring*, no significant differences were found for the scoring of the emotional and sensory terms between the two conditions for sample A. The intensity scoring for the sensory attributes 'soft', 'creamy' and 'sweet' was significantly higher when consumers evaluated the branded sample of B. Sample C was significantly evaluated more as 'thick' during the branded evaluation. Also, the emotional terms 'disappointed' and 'sad' were more intensively associated with private label sample C under the informed conditions. Previous research, even with vanilla milk desserts, has already found that information can alter the intensity perception of sensory attributes, as was the case for samples B and C (Stolzenbach *et al.*, 2013; Vidal *et al.*, 2013). Other studies have illustrated that brands have different emotional profiles (Crocker & Thomson, 2014; De Pelsmaeker *et al.*, 2013; Spinelli *et al.*, 2015; Thomson & Crocker, 2014; Thomson & Crocker,

2015), and this could explain why there are differences in the association with emotions for sample C. An overview of results for the third experiment is given in Table 2.6.

Table 2.6 Summary of the results of the experiment with pudding in blind (n=77) and informed (n=65) conditions

	Pudding A	Pudding B	Pudding C
Blind evaluation			
Mean liking (S.D.)	5.97 (1.46)	5.95 (1.92)	5.52 (1.62)
Emotional terms with significant differences between samples	RATA: happy*		
	RATA: scoring calm*, disappointed***, dissatisfied*, enjoyment*, good***, happy***, satisfied***, worried**		
Sensory terms with significant differences between samples	RATA: aftertaste***, soft***, vanilla flavour*		
	RATA scoring: creamy***, firm**, liquid*, milky flavour**, soft***, thick***, vanilla aroma*, vanilla flavour*		
Informed evaluation			
Mean liking (S.D.)	5.63[a] (1.52)	6.69[b] (1.50)	5.18[a] (1.66)
Emotional terms with significant differences between samples	RATA: desire*, disappointed*, dissatisfied*, sad*, satisfied*		
	RATA scoring: desire**, disappointed*, dissatisfied**, sad*, satisfied***		
Sensory terms with significant differences between samples	RATA: milk flavour**, off-flavour*, sweet***, vanilla aroma***, vanilla flavour**		
	RATA scoring: aftertaste*, creamy**, milk flavour*, off-flavour*, sweet***, vanilla aroma***, vanilla flavour***		

[a,b] liking of pudding with no common superscripts differ significantly ($p \leq 0.05$)

*,**,*** indicates significant differences at $p \leq 0.05$, $p \leq 0.01$, $p \leq 0.001$

This experiment shows that the EmoSensory® Wheel can be applied to detect emotional and sensory differences in either blind or informed conditions, similar to research studies based on conventional surveys. The influence of brand information on the emotional and sensory profile of food products, as shown by the significant differences in association with emotions and sensory terms between both conditions, are in line with previous research (Spinelli *et al.*, 2015). The larger sample discrimination, when analysing the RATA data (weighted attribute scores) during the blind evaluation, supports the findings of Ares *et al.* (2014).

2.4.2. Consumers' perception of the EmoSensory® Wheel

2.4.2.1. Experiment 1: crisps, cola and chocolate

Most consumers who participated in the first experiment found it easy (mean = 4.5, S.D. = 1.8) to use the EmoSensory® Wheel (Figure 2.11). Compared to the RATA experiments by Ares *et al.* (2014) and Jaeger and Ares (2015), using sensory attributes, Belgian consumers tended to find the task less easy. Lower scores were mainly given by the elderly, who suggested rotating the wheel on a touch screen instead of using a computer mouse. Some consumers commented that they found it a little bit strange to associate emotions with food products. This has also been reported in previous research (Jaeger, Cardello, & Schutz, 2013; Köster & Mojet, 2015). The task involving emotional and sensory characterization using the wheel was experienced as fun and enjoyable, as most consumers (mean = 2.8, S.D. = 1.6) disagreed when asked if the task was tedious. Results concerning tediousness are in line with previous research (Ares *et al.*, 2014; Jaeger & Ares, 2015).

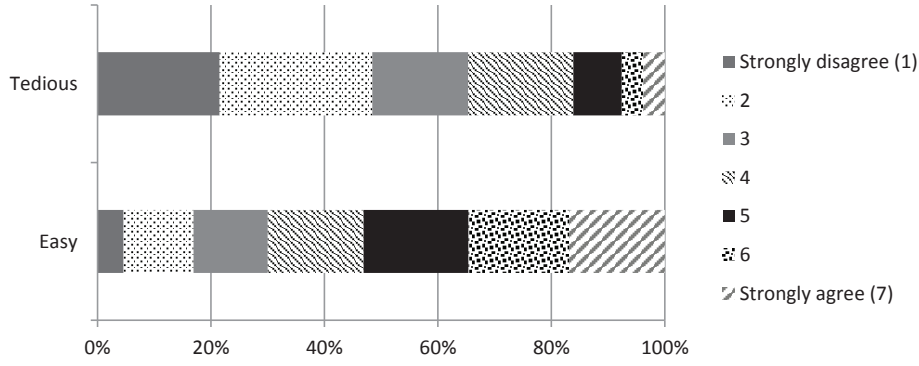

Figure 2.11 Easiness and tediousness of the use of the EmoSensory® Wheel during the first experiment with crisps, chocolate and cola (n = 130)

2.4.2.2. Experiment 3: vanilla pudding

The use of the EmoSensory® Wheel was easy (mean = 4.6, S.D = 1.7) for most consumers during the blind test with vanilla pudding (Figure 2.12). These participants disagreed when asked if the task was tedious (mean = 2.8, S.D. = 1.5). Similar results were obtained during the informed test with a mean score of 5.1 (S.D. = 1.7) for easiness and 2.8 (S.D. = 1.8) for tediousness. These results are similar to those obtained from the first experiment and a RATA experiment by Ares *et al.* (2014) using a regular questionnaire format for the sensory characterization of milk desserts.

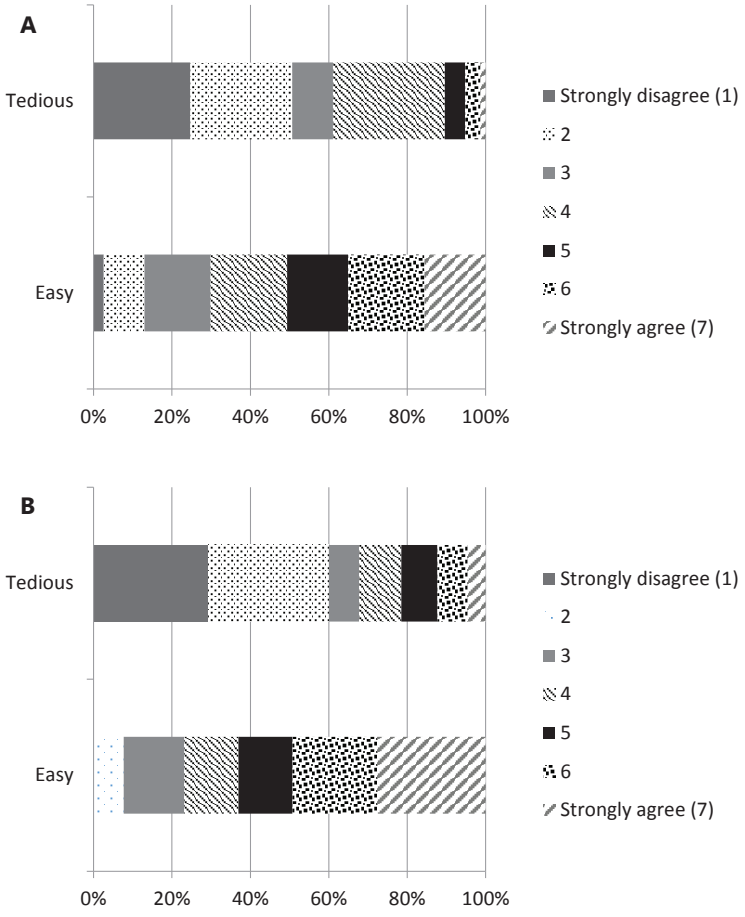

Figure 2.12 Easiness and tediousness of the use of the EmoSensory® Wheel during the vanilla pudding experiment in blind (panel A, n = 77) and informed (panel B, n = 65) condition

2.4.3. Linking emotional and sensory profiling

One of the major assets of the new method is the combined elicitation of the emotional and sensory profile of food products. While the emotional and sensory profiles of food products can be analysed separately with statistical methods, it is interesting to apply sensometric methods in order to examine the linkages between the emotional and sensory profiling. The combination of both the emotional and sensory profiling might offer interesting insights for the SensoEmotional optimization of food products (Thomson, 2007). This section will briefly illustrate the use of MFA with the intensity data obtained from the third experiment with vanilla pudding under the informed condition.

MFA is a technique to examine several tables of variables in order to study the relationship between variables, tables and observations (Pages, Escofier, & Haury, 1991). The first and second dimensions sorted the samples according to their emotional conceptualisations and sensory descriptions by consumers. The advantage of this type of representation is that it summarizes both emotional and sensory data, considering both as active variables. Based upon the MFA plot (Figure 2.13a), it is clear that the emotional conceptualisation 'enjoyment' is strongly correlated with several positively valenced emotional terms such as 'creamy', 'firm', 'vanilla flavour' and 'sweet'. The sensory term 'liquid' was highly correlated with 'sad' and 'discontented' suggesting that vanilla pudding producers should pay enough attention to the viscosity of their products. The first dimension is highly associated by the emotional conceptualisations 'contented' and 'desire' alongside the sensory terms 'creamy', 'vanilla flavour' and 'aftertaste'. On the other hand, 'soft', 'sour', 'thick', 'off-flavour' and 'light colour' highly contributed to the second dimension together with the emotional conceptualisations 'guilty', 'calm' and 'worried'. The product representation map of the pudding samples as mean points, depicting two points representing sensory and emotional profiles, is presented in Figure 2.13b. The relatively small distance between those partial points is illustrated in a moderate RV coefficient (0.819). The product representations were clearly different from each other as they were not located near each other.

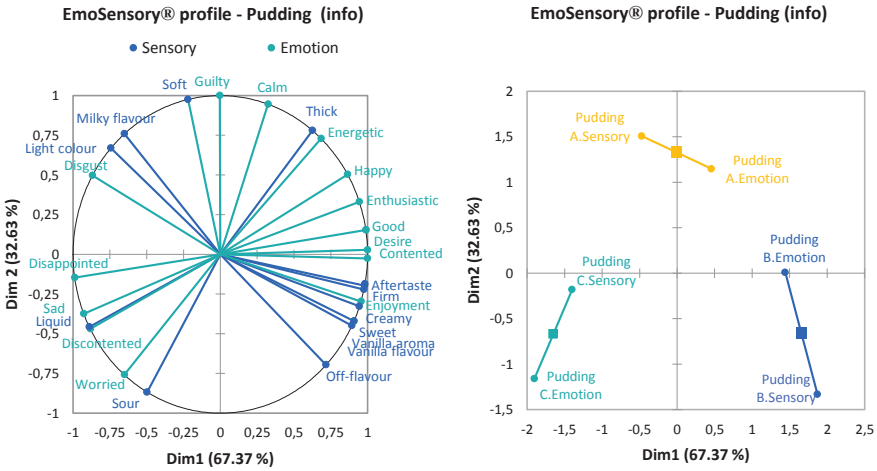

Figure 2.13 Representations of emotional and sensory terms (a) and samples (b) in the first two dimensions of MFA

2.5. Discussion

This chapter discussed the use of a wheel questionnaire format, called EmoSensory® Wheel, to obtain both sensory and emotional characterization of food products by consumers. Until now, a wheel format has been mainly used as an instrument for sensory characterization during panel training (e.g. beer flavour wheel (Meilgaard *et al.*, 1979)) and obtaining information about emotions (e.g. GEW) independently.

The development of our EmoSensory® Wheel followed suggested scientific approaches for term selection (Jiang *et al.*, 2014; Ng *et al.*, 2013a; Thomson & Crocker, 2014) and incorporates the recent RATA approach (Ares *et al.*, 2014; Reinbach *et al.*, 2014) as scaling technique. However, one need to bear in mind that using the RATA method could lead to lower responses compared to other scaling techniques which should be examined in future studies. Based on three different experiments, it is demonstrated that this tool can discriminate between (highly likeable food products: crisps, cola and chocolate) and within product categories (burgers, vanilla pudding). The EmoSensory® Wheel could provide additional information even when acceptability of the products is similar, according to previous research on the contribution of emotions as a discriminating factor for equally liked products (King & Meiselman, 2010; Spinelli *et al.*, 2014). Further, the experiment of burgers illustrated that the tool could be discriminative even when the overall liking is low (e.g. 3.52 on a 9-point scale). However, one should take these low liking scores into account when interpreting the results as there is currently little known about the potential role of using low-liking products on emotional and sensory profiling.

Our purpose was to create an alternative and consumer-friendly way to collect data compared to a standardized questionnaire. On average, most consumers found it an easy task to fulfil and did not find it tedious to perform the task using the wheel format. These results were in line with the traditional questionnaire format using the same RATA approach in experiments on several food products, such as milk desserts (Ares *et al.*, 2014), peas (Jaeger & Ares, 2015), peanuts (Jaeger & Ares, 2015) and crackers (Jaeger & Ares, 2015). A future improvement could be the use of a touchscreen for ease of rotation, which was mainly suggested by elderly people. This chapter focused on the potential for using the tool to discriminate within and between food products. As such, no experiments were included that directly compared this method to a traditional questionnaire format. Future research is needed to compare both formats regarding their effectiveness for data collection and user-friendliness in an advanced research design.

One should note that these experiments worked with product-specific questionnaires, which are expected to be more discriminating in comparison to a standardized questionnaire (Ng *et al.*, 2013a). Standardized emotion questionnaires contain many items to ensure that no important terms are missed (Jaeger, Cardello*, et al.*, 2013; Spinelli *et al.*, 2015). However, this can have negative consequences for the quality of data collected and the cooperation of

respondents due to boredom and fatigue (Jaeger, Cardello*, et al.*, 2013; Ng *et al.*, 2013a; Spinelli *et al.*, 2014). Including too many terms could lead to the measurement of emotions evoked by the task itself rather than the food being tested. As the purpose is to develop an alternative and more attractive way of collecting data in consumer tests, it is also crucial not to make the task too onerous. Therefore, we opted to restrict the number of both sensory and emotional terms (with a maximum number based on suggestions by Jaeger *et al.* (2015)) and to use a product-specific list. While product-specific lists are normally shorter, one could also opt for a standardized emotion list to gain time, e.g. for commercial goals. Also, the authors opted to balance the emotional terms based upon their valence for the product-specific emotional list in order to obtain a global overview and as this could be valuable for product development purposes (Meiselman, 2015; Ng *et al.*, 2013a). As the inclusion criteria should be based upon the purpose of the study, other researchers could for instance decide to use more positive or negative emotional terms (Jiang *et al.*, 2014; Schifferstein & Desmet, 2010).

The use of CATA instead of RATA scaling can also be useful in certain situations. However, this chapter showed the potential added value from using the recent RATA scaling technique. When RATA data was analysed as weighted attribute scores, some additional significant differences were identified, for instance, when terms differ in their perceived intensity, as observed by Ares *et al.* (2014). However, our experiments indicated that this depends on the products used, as suggested by Ares *et al.* (2014). Although more research is needed to examine the effectiveness of this tool when using CATA, the choice of scale should also depend on the purpose of the research. CATA is more suitable for fast characterisation and reduces response time, while RATA can be more interesting when the focus is on intensity or in-depth characterization (Meiselman, 2015). Furthermore, RATA is likely to trigger a more analytical mindset in consumers, which could also influence other tests. For instance, an improved hedonic discrimination between the samples has been observed (Ares *et al.*, 2014; Jaeger *et al.*, 2015).

Consumers first performed a hedonic evaluation of a sample and then, subsequently, completed the sensory and emotional profiling of the sample. One needs to bear in mind that asking analytical ratings for a product could influence the overall liking for it (Earthy, MacFie, & Hedderley, 1997; Popper *et al.*, 2004; Prescott, Lee, & Kim, 2011). However, studies using the CATA approach for the sensory characterization of a range of food and beverages found little evidence of a possible hedonic bias by applying concurrent sensory product characterization (Ares & Jaeger, 2015; Jaeger & Ares, 2014; Jaeger, Giacalone*, et al.*, 2013). Also, a recent study involving five different product categories shows that RATA questions about sensory attributes do not lead to a bias when performing a concurrent hedonic evaluation (Jaeger & Ares, 2015). However, emotional measurements are considered more as hedonic measurements (Köster & Mojet, 2015) and are thus more likely to bias the hedonic liking. Therefore, the authors opted to assess overall liking before the EmoSensory® Wheel to avoid a possible bias from mentioning emotion terms, as observed by King *et al.* (2013). Further research is needed to investigate whether there is an influence and if overall liking should be assessed before or after

the EmoSensory® characterization of food products. As suggested by Ares and Jaeger (2015), it is advisable to request hedonic measurements if the goal is to characterize products. The experiments with the burgers took place in a laboratory environment, whereas consumers tasted the milk pudding during a consumer fair. A question arises regarding the potential influence of the setting and context on the evaluations performed. Several studies have already investigated the influence of an actual (Desmet & Schifferstein, 2008; Porcherot, Petit, Giboreau, Gaudreau, & Cayeux, 2015) or imaginary context (Piqueras-Fiszman & Jaeger, 2014a, 2014b, 2014c) on the emotional evaluation of food products. It is known that the context could influence consumers' sensory evaluation of food products (Edwards, Meiselman, Edwards, & Lesher, 2003; Köster, 2003). In the laboratory, for example, people are likely to be more focused on the fact that they are participating in a test and this may influence the results. Another option is to perform the test as a home-use test (HUT),which better fits a real eating situation, but is more difficult to control (Jiang *et al.*, 2014). The vanilla experiment took place during a consumer fair, as the tool currently only needs a web browser and internet connection. It can easily be used on such locations, and even for HUT, using computers or tablets. For future research purposes, one could try to simulate an environment in order to reduce possible context bias, as suggested by Köster (2003) or even measure emotions in the desired environment itself (e.g. supermarket, HUT, restaurant) (Porcherot *et al.*, 2015).

Future research could further improve and validate the use of the wheel question format in different languages and cultures. By using a consumer-defined lexicon for sensory and emotional terms, for instance, it is possible to include important terms in a specific language or culture which may not be included within a general list like the EsSense Profile™. One drawback is that the terms (and their interpretation) could differ between different languages and cultures, especially as emotional terms are sometimes culture-specific (Herz, Schankler, & Beland, 2004; Köster & Mojet, 2015; Tsai & Chentsova-Dutton, 2003). Therefore, the 'equivalent' translation for a particular emotional term, is not always clear (Spinelli *et al.*, 2014), which makes cross-cultural and interlingual comparison more complex. Future studies could also work with larger and representative consumer samples. Not only could this offer additional insights, this will also make it feasible to examine differences between different consumer segments. This will also facilitate more advanced statistical analyses of the obtained consumer data. Further, terms were listed in alphabetical order so consumers could become acquainted with the wheel and to reduce time over other sample evaluations. Although, it would be ideal to randomize the term order, previous research has shown that emotional or sensory term order has little impact on the profiling results (Ares & Jaeger, 2013; King & Meiselman, 2010).

Although we demonstrated the potential of the EmoSensory® Wheel with several food products, further research could target other food products (especially beverages and non-snack products) and even include other types of conceptualization (functional or abstract terms). Furthermore, this study showed that the actual purpose of the test needs to be considered when deciding which testing condition to use during the experiment. Serving the

samples with just a random code number gives valuable information on the actual emotions and sensory product characterization. However, in real life, most consumers know the product brand, for instance, and this could influence the product's emotional and sensory profile, as illustrated by previous research (Crocker & Thomson, 2014; Spinelli *et al.*, 2015; Stolzenbach *et al.*, 2013; Thomson & Crocker, 2015), and provide a more realistic view. This chapter used a between-subjects design. If the focus lies on investigating the influence of a brand effect or even information in general, one should also examine the influence of expectations (e.g. Cardello (2007)) and potentially opt for a within-subjects design.

In conclusion, the EmoSensory® Wheel shows the potential to be an alternative, well-accepted animated method to obtain both an emotional and sensory profile for food products by consumers and can be applied in different research settings. Although this tool was developed in an academic setting, it also yields possibilities for use in food product development and commercial purposes. As sensory attributes are assumed to influence emotional product conceptualizations (Thomson *et al.*, 2010), this tool can help to further address this knowledge gap by examining crosslinks between sensory and emotional profiles.

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Chapter 3

EmoSensory® Wheel: convergent validity, response formats and concurrent hedonic assessment

This chapter is based on:
Schouteten, J.J., De Steur, H., De Bourdeaudhuij, I., Sas, B., Bredie, W.L.P., Perez-Cueto Eulert, F.J.A., & Gellynck, X. Validating the EmoSensory® Wheel: comparison with list-based questionnaire format, use of response formats and influence on concurrent hedonic assessment. *Submitted.*

Abstract
The study of emotional and sensory profiling with food products is gaining momentum in order to obtain a broader consumers' perspective on product performance beyond traditional hedonic measures. The EmoSensory® Wheel, the method introduced in the second chapter which combines emotional and sensory assessment in a wheel-based questionnaire format is one example to conduct such a task in a consumer-friendly way. However, little is known about its performance compared to a traditional list-based questionnaire format. This is examined in this chapter for two product categories (chocolate and yogurt). Further, two methodological issues by (i) comparing the use of check-all-that-apply (CATA) and rate-all-that-apply (RATA) scaling formats and (ii) examining if the method impacts the concurrent hedonic assessment of product were studied. Although both questionnaire formats gathered similar findings, most consumers preferred the wheel-based questionnaire format. Regarding the latter, CATA and RATA scaling yielded similar performance and no influence on the concurrent hedonic assessment was found. This study lend further support for combining emotional and sensory measurements using the EmoSensory® profile which is of interest for food scientists and industry.

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3.1. Introduction

Sensory science heavily relies on the hedonic assessment of food products to obtain an understanding of product performance by consumers (Lawless & Heymann, 2010; Martens, 1999; Stone, Bleibaum, & Thomas, 2012). However, high failure rates of new food products suggest that hedonic assessment alone is an insufficient predictor of actual food choice as food choice is a result of several interlocking determinants such as hedonics, experience, attitudes, personal beliefs and habits (Gedrich, 2003; Köster & Mojet, 2012; van Kleef, van Trijp, & Luning, 2005). A broader view on how consumers really experience food products is needed, calling for consumer research that combines sensory profiling and emotional profiling (Gutjar, de Graaf*, et al.*, 2015; Stolzenbach, Bredie, Christensen, & Byrne, 2013; Thomson, 2007).

While the sensory characterization of foods is traditionally based upon measurements with trained panel experts, several new techniques have been introduced to work with actual consumers for the sensory description of products (Valentin, Chollet, Lelievre, & Abdi, 2012; Varela & Ares, 2012). In general, four types of sensory profiling techniques with consumers (here understood as non-trained in sensory description of foods) can be distinguished: methods based on the evaluation of individual attributes (e.g. check-all-that-apply, intensity scales, flash profiling, paired comparisons); methods based on the evaluation of global differences (e.g. sorting, Napping®); methods based on the comparison with product references (e.g. polarized sensory positioning), and based on a free, global evaluation of the individual products (e.g. open-ended questions) (Varela & Ares, 2012).

Several studies have been carried out to examine what people associate with food products with a major focus on emotional conceptualisations during the last few years (Jiang, King, & Prinyawiwatkul, 2014; Köster & Mojet, 2015; Thomson & Crocker, 2015). Emotions and feelings can be measured as self-reports, by observational techniques (e.g. facial expressions) or by autonomic responses (e.g. heart rate, skin conductance) and brain imaging techniques (e.g. fMRI) (de Wijk, Kooijman, Verhoeven, Holthuysen, & de Graaf, 2012; Köster & Mojet, 2015). Within food research, verbal self-report measurement techniques to determine emotional associations by consumers are often employed (Jiang *et al.*, 2014; Köster & Mojet, 2015; Ng, Chaya, & Hort, 2013a). Consumers are asked which emotionally charged words (Desmet & Schifferstein, 2008; King & Meiselman, 2010; Laros & Steenkamp, 2005; Thomson, Crocker, & Marketo, 2010) or sentences (Spinelli, Masi, Dinnella, Zoboli, & Monteleone, 2014) they associate with a food product when performing a verbal self-report task.

Despite the growing body of literature using those profiling techniques, little is known about combining the elicitation of sensory and emotional profiling (Ng *et al.*, 2013a). The EmoSensory® Wheel (Schouteten *et al.*, 2015), a recently introduced technique which enables the assessment of both sensory and emotional profiling by consumers using an integrated wheel questionnaire format, might therefore offer new insights. However, some important methodological issues need to be addressed when applying this method that shows potential for a more facile data collection. First, the question arises how this wheel questionnaire format

performs compared to a traditional list-based questionnaire format which examines the convergent validity (Carmines & Zeller, 1979) of the EmoSensory® Wheel. Second, the wheel questionnaire format has only been applied using the recent rate-all-that-apply (RATA) scaling while it is unclear if also the widely applied check-all-that-apply (CATA) approach could detect discriminatory differences between sensory profiles. Third, it is known that emotional (Gutjar, Dalenberg*, et al.*, 2015; King, Meiselman, & Carr, 2013) and sensory profiling (Jaeger & Ares, 2015) does not bias the concurrent hedonic assessment. But it is unclear if this is also the case when consumers are asked to conduct both emotional and sensory profiling using CATA and RATA scaling approaches.

The aim of this study is to address three issues of the EmoSensory® Wheel by conducting three experiments using two product categories (chocolate and yogurt): (i) comparing the performance of wheel-based questionnaire format with list-based questionnaire format, (ii) investigating the influence of the response format (CATA vs. RATA) on the performance of the EmoSensory® Wheel and (iii) examining the effect of the EmoSensory® Wheel on the concurrent hedonic assessment.

3.2. Materials and methods

3.2.1. Experimental design

This chapter addresses three different experiments. Each experiment consisted of two separate studies, one involved the use of three chocolate samples while the other study worked with yogurt samples. While chocolate is a confectionary product for a pleasure seeking experience, this is less the case for yogurt which has strong nutritional and health associations (Sosa, Cardinal, Contarini, & Hough, 2015).

The *first experiment* compared the use of a traditional questionnaire format with the EmoSensory® Wheel using a within-subjects design. This first experiment consisted of three sessions. During a first (training) session, consumers evaluated crisps using the two different questionnaire formats in order to get acquainted to the task. In session two the chocolate or yoghurt samples were evaluated. In this session half of the participants conducted the emotional and sensory profiling using the list-based questionnaire format (Figure 3.1), while the other half of the sample conducted the same task but with the EmoSensory® Wheel (Figure 3.2). During the third session, scheduled a week apart from the second session, the other questionnaire format was used for the sensory and emotional profiling of the focal product by the consumers. A *second experiment* explored the influence of two different response formats namely RATA (Figure 3.2) vs CATA (Figure 3.3) when applying the EmoSensory® Wheel method during a between-subjects design. Next to this, a *third experiment* (between-subjects design) evaluated if conducting emotional and sensory profiling influenced the concurrent hedonic rating scoring.

3.2.2. Participants

Adult participants, aged 18-65 years old, were recruited from the university campus to participate in the studies. Consumers involved in a study were regular consumers of the focal product as recommended by King and Meiselman (2010). Participants were randomly assigned to a test condition in the second and third experiment. The participant profiles (age and gender) of the between-subjects experiments were similar in each test condition (Table 3.1).

Table 3.1 Research design and participant profiles of each study (chocolate / yogurt) for each experiment

	Experiment 1 Questionnaire format		Experiment 2 Response format		Experiment 3 Hedonic assessment	
	Chocolate	Yogurt	Chocolate	Yogurt	Chocolate	Yogurt
Research design	Within-subjects	Within-subjects	Between-subjects	Between-subjects	Between-subjects	Between-subjects
Total number of respondents	50	50	123	105	162	164
Gender (M/F)	14/36	12/38	CATA: 21/37 RATA: 23/36	CATA: 17/34 RATA: 20/34	HED: 22/37 CATA: 21/37 RATA: 23/36	HED: 23/36 CATA: 17/34 RATA: 20/34
Mean age (S.D.)	28.3(7.7)	28.2(7.7)	CATA: 25.3(6.7) RATA: 24.2(8.4)	CATA: 26.6(7.1) RATA: 25.1(7.4)	HED: 26.4(10.7) CATA: 25.3(6.7) RATA: 24.2(8.4)	HED: 28.5(12.6) CATA: 26.6(7.1) RATA: 25.1(7.4)

M/F means male / female, HED: means only hedonic assessment, CATA / RATA means EmoSensory® Wheel with CATA / RATA as response format applied next to hedonic assessment

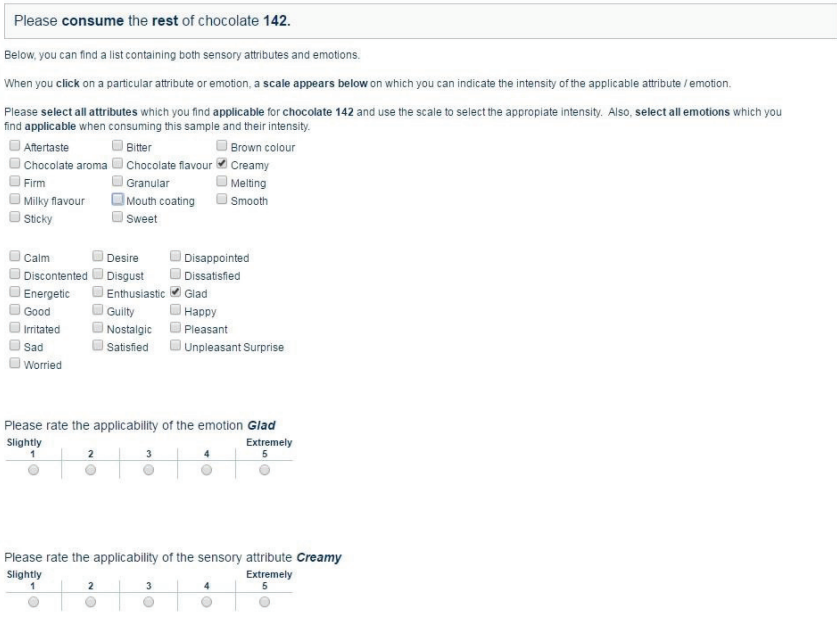

Figure 3.1 Example of the list-based questionnaire format using the RATA response format for a chocolate sample

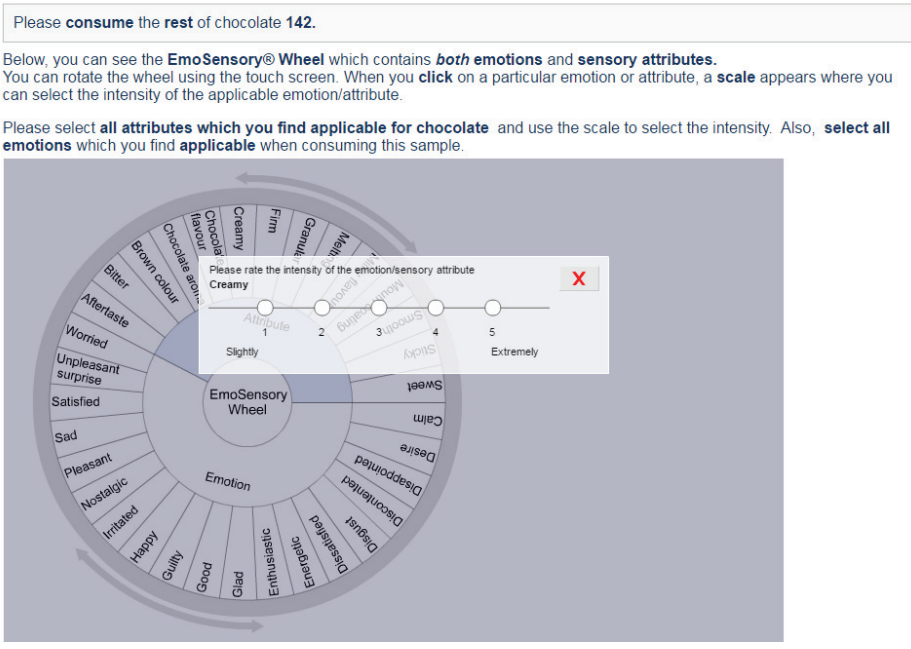

Figure 3.2 Example of the wheel-based questionnaire format using the RATA response format for a chocolate sample

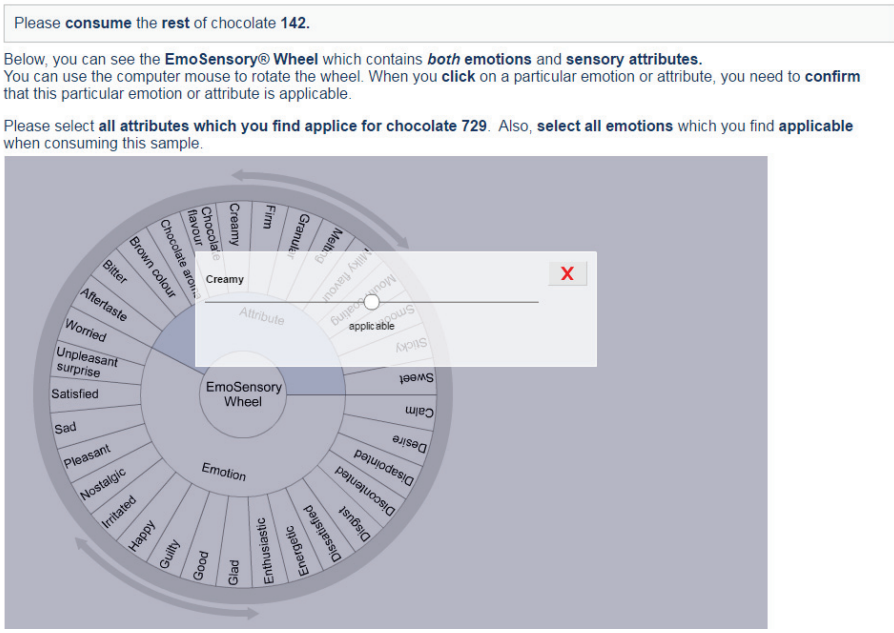

Figure 3.3 Example of the wheel-based questionnaire format using the CATA response format for a chocolate sample

3.2.3. Products and terms

Two product categories were tested during these experiments: chocolate and yogurt. All samples were commercially available and purchased in local supermarkets. The number of evaluated samples during each study were limited to three in accordance with guidelines regarding emotional research using food products (King *et al.*, 2013). Three chocolates were selected based upon their variety of sensory characteristics and marketing position (C1: Belgian premium brand; C2: Swiss premium brand; C3: local brand). All three yogurts were from the same premium brand but differed in fruit flavour (Y1: blueberry; Y2: strawberry and banana; Y3: pear and apricot).

Consumer-defined product-specific emotion and sensory lexicons were established for the products (Table 3.2). Following the suggestions of prior research (Jiang *et al.*, 2014; Ng *et al.*, 2013a), emotion terms were determined following a two-step procedure. First, a group of consumers (n = 20) selected which emotional conceptualisations they associate when consuming several product samples using a list containing emotional terms of prior research (Desmet & Schifferstein, 2008; King & Meiselman, 2010; Laros & Steenkamp, 2005; Thomson *et al.*, 2010). Participants also had the opportunity to add any missing terms. This consumer-generated list was used by the researchers to make a final selection using three criteria: (i) frequency of term selection, (ii) possibility to discriminate between samples and (iii) balance between positively and negatively valences of the emotional terms (Ferrarini *et al.*, 2010; Jiang

et al., 2014; Manzocco, Rumignani, & Lagazio, 2013; Ng *et al.*, 2013a; Schouteten *et al.*, 2015). A similar two-step approach has been applied to determine the sensory lexicon (Schouteten *et al.*, 2015). The selected sensory terms covered multiple sensory modalities: appearance, aroma, flavour, texture and aftertaste (Ares, Antúnez*, et al.*, 2014).

Table 3.2 List of final emotional and sensory terms used in the chocolate and yogurt studies

Chocolate		Yogurt	
Emotional terms	*Sensory terms*	*Emotional terms*	*Sensory terms*
Calm^{u}	Aftertaste	Bored^{-}	Aftertaste
Desire^{+}	Bitter	Calm^{u}	Creamy
Disappointed^{-}	Brown colour	Contented^{+}	Dark colour
Discontented^{-}	Chocolate aroma	Disappointed^{-}	Firm
Disgust^{-}	Chocolate flavour	Discontented^{-}	Fruit aroma
Dissatisfied^{-}	Creamy	Disgust^{-}	Fruit flavour
Energetic^{+}	Firm	Dissatisfied^{-}	Homogeneous
Enthusiastic^{+}	Granular	Friendly^{+}	Liquid
Glad^{+}	Melting	Frustrated^{-}	Milky flavour
Good^{+}	Milky flavour	Good^{+}	Off-flavour
Guilty^{-}	Mouthcoating	Happy^{+}	Smooth
Happy^{+}	Smooth	Interested^{+}	Sour
Irritated	Sticky	Pleasant^{+}	Sweet
Nostalgic^{+}	Sweet	Pleasant surprise^{+}	Thick
Pleasant^{+}		Satisfied^{+}	
Sad^{-}		Stressed^{-}	
Satisfied^{+}		Steady^{u}	
Unpleasant surprise^{-}		Unpleasant surprise^{-}	
Worried^{-}			

$^{+,-,u}$ means positive / negative / unclassified emotion respectively

3.2.4. Evaluation procedure

The procedure for data collection in experiments 1 and 2 was similar. Participants first provided their hedonic liking (9-point scale) of a sample after which they conducted the emotional and sensory profiling. During the first experiment, consumers also assessed the easiness, tediousness and adequateness of the used method (i.e. traditional list-based questionnaire or EmoSensory® Wheel questionnaire format) on a 7-point Likert scale for conducting the sensory and emotional profiling task (Ares, Bruzzone*, et al.*, 2014). The same questions about easiness and tediousness, with Likert scales, were also included in the second experiment. During the last session, participants were asked to indicate and describe which method they preferred. As the third experiment examined the influence of emotional and sensory profiling on the concurrent hedonic liking elicitation, around one third of the consumers only assessed the overall liking of the products during the third experiment.

Samples were presented in monadic sequence following Williams design (MacFie, Bratchell, Greenhoff, & Vallis, 1989) balanced for order and carry-over effects. All samples were presented with a three-digit code in a plastic transparent cup and participants were offered enough sample to facilitate three bites/tablespoons. Chocolate samples were offered at room temperature while yogurt samples were refrigerated at 4°C until the moment of serving. Further, participants were instructed to rinse their mouth with water between the evaluations

of the different samples. Emotional and sensory terms were presented in alphabetical order to ease the profiling process but also because previous research suggested that attribute order has little impact on the results (Ares & Jaeger, 2013; King *et al.*, 2013). Automated data-acquisition software EyeQuestion v3.15.10 was used during each test.

3.2.5. Data analysis

Hedonic liking scores of the products were compared in the first and second experiment using a repeated measures analysis of variance (ANOVA).

Data obtained from RATA scales can be analysed using two different approaches: (i) frequency of selection or (ii) weighted frequency of selection (RATA scoring) (Ares, Bruzzone*, et al.*, 2014). The second approach allocated the points of the scale (ranging from 1 to 5) to numbers in increasing order. The weighted RATA scoring for each emotional and sensory term were calculated by summing up these scores.

The procedure for data analysis in the first and second experiment was similar. For each experimental treatment, the term usage was determined by counting the number of consumers that used a term during the emotional/sensory profiling of a sample. Cochran's Q test was performed to determine significant differences in the frequency of term selection between the three samples in each condition. Friedman's test was carried out on data from RATA scoring to identify significant differences between the samples in a treatment. Correspondence Analysis (CA) was performed on the frequency table from each condition considering chi squares distances (Vidal, Tárrega, Antúnez, Ares, & Jaeger, 2015). As the RATA approach facilitates two ways of analysis, CA was performed on the frequency table containing the frequency of use of a term for each sample (RATA) and on the weighted RATA scoring of each term for a given sample. The RV coefficient (Robert & Escoufier, 1976) has been calculated to determine the sample and term configurations in the first two dimensions for emotional or sensory terms.

Easiness-to-perform, tediousness and perceived adequateness between the question formats (experiment 1) were compared using Wilcoxon signed-rank test. Mann-Whitney U-test was carried out to compare the easiness-to-perform and tediousness of the CATA with RATA scaling format (experiment 2).

Linear mixed modelling was performed to examine if introducing the wheel-based questionnaire format influenced the hedonic ratings during the third experiment for both studies separately. Hedonic rating was the dependent variable in the models. Treatments (hedonic only, hedonic + wheel with CATA response format, hedonic + wheel with RATA response format), samples and their interaction were treated as fixed effects, whereas consumer (within experimental treatment) was considered as a random effect (Jaeger & Ares, 2015).

Statistical analyses were performed using IBM SPSS Statistics 22.

3.3. Results

3.3.1. Experiment 1: Comparison emotional and sensory profiling by wheel-based and list-based questionnaire formats.

Significant differences were found in the mean hedonic liking in the chocolate studies, consumers' overall acceptance of the yogurt products did not differ significantly (Table 3.3a). However, no significant differences were found for the overall acceptance of a sample when comparing the list-based and wheel-based questionnaire format.

Consumers used a similar number of sensory and emotional terms during the two questionnaire formats to describe the samples (Table 3.3b). This was the case for both the chocolate and yogurt study, though it is interesting to notice that sensory terms were more often used compared to emotional terms. Percentages of sensory terms are ranging from 38% to 42%, which are similar numbers to those reported for the sensory profiling of milk desserts, bread and gummy lollies using the RATA scoring technique (Ares, Bruzzone*, et al.*, 2014). Also the average percentages of emotional terms selected are in line with previous reported results (King *et al.*, 2013; Piqueras-Fiszman & Jaeger, 2014a).

Results related to the sample differences for emotional and sensory terms can be found in Table 3.3c. Differences between the two questionnaire formats were rather limited (maximum 2 terms). Four times, the wheel-based format had a higher discriminability compared to the traditional list-based questionnaire format while the list-based questionnaire format was only in one case more discriminative than the EmoSensory® Wheel.

Sample configurations of both questionnaire formats were highly similar for both studies (Table 3.3d). Regarding the sensory terms, all RV coefficients obtained values higher than 0.80. The RV coefficients between emotional terms configurations were lower than those of the sensory terms but they still reached significance ($p \leq 0.001$).

Table 3.3 Comparison of the emotional and sensory profiling using the list-based and wheel-based questionnaire format in the chocolate (n = 50) and yogurt (n = 50) study

	Chocolate		Yogurt	
	List-based	Wheel-based	List-based	Wheel-based
a. Mean hedonic liking (S.D)	C1: 6.0[a](1.8) C2: 6.6[a](1.6) C3: 4.0[b](1.5)	C1: 5.7[a](1.9) C2: 6.4[a](1.7) C3: 4.0[b](1.9)	Y1: 5.5(1.9) Y2: 5.7(1.9) Y3: 5.3(1.6)	Y1: 5.4(2.1) Y2: 5.6(1.9) Y3: 5.2(1.9)
b. Term usage				
Average percentage of emotional terms used to describe samples	19%	17%	16%	15%
Average percentage of sensory terms used to describe samples	41%	42%	38%	39%
c. Sample differences				
Number of emotional terms with significant differences among samples ($p \leq 0.05$)	RATA: 13 RATA-S: 14	RATA: 14 RATA-S: 13	RATA: 1 RATA-S: 2	RATA: 2 RATA-S: 2
Number of sensory terms with significant differences among samples ($p \leq 0.05$)	RATA: 6 RATA-S: 9	RATA: 6 RATA-S: 11	RATA: 6 RATA-S: 6	RATA: 7 RATA-S: 6
d. Sample configurations				
RV between sample configurations obtained from CA of emotional data from list-based and wheel-based format	RATA: 0.99*** RATA-S: 0.99**		RATA: 0.99*** RATA-S: 0.99***	
RV between term configurations obtained from CA of emotional data from list-based and wheel-based format	RATA: 0.71*** RATA-S: 0.91***		RATA: 0.76*** RATA-S: 0.55***	
RV between sample configurations obtained from CA of sensory data from list-based and wheel-based format	RATA: 1.00*** RATA-S: 1.00***		RATA: 0.94 RATA-S: 1.00***	
RV between term configurations obtained from CA of sensory data from list-based and wheel-based format	RATA: 0.87** RATA-S: 0.87**		RATA: 0.82** RATA-S: 0.97**	

CA = Correspondence analysis;

RATA: data were analysed by only taking the frequency of selection into account; RATA-S: data were analysed by creating a summed index of the scores provided by all participants for each of the terms of the question;

Samples with different superscript letter in the hedonic liking scores differ significantly within a questionnaire format ($p < 0.05$);

RV score significance level: **, $p < 0.01$; ***, $p < 0.001$

Significant differences were not found regarding the easiness-to-perform, tediousness and adequateness of both methods for conducting the emotional and sensory profiling task (Table 3.4). Most participants found it an easy task, regardless of it involved chocolate or yogurt samples. On average, consumers disagreed to the statement that the task was tedious during the chocolate and yogurt study. For both questionnaire formats, consumers agreed that it was

an adequate way to conduct the profiling task for the chocolate questionnaire. Similar results about the adequateness of the questionnaire formats were obtained during the yogurt study. Although both questionnaire formats were evaluated as similar on the level of easiness, tediousness and adequateness, a majority of the participants during both studies (78% for chocolate and 72 % for yogurt) preferred the EmoSensory® Wheel. Respondents highlighted the visualization, better and compact overview as the main reasons for their preference of the wheel-based format. On the other hand, consumers who preferred the list-based questionnaire format tended to be older and listed that that this format is sometimes easier to navigate and perceived it as somewhat quicker.

Table 3.4 Mean (S.D.) scores of the perceived easiness, tediousness and adequateness for conducting the emotional and sensory profiling task using the list-based and wheel-based questionnaire format in the chocolate (n = 50) and yogurt (n = 50) study measured on an anchored 7-point scale (1 = totally disagree – 7 = totally agree). No significant differences were found regarding the easiness-to-perform, tediousness and adequateness for conducting the profiling task between the list-based and wheel-based questionnaire format.

	Chocolate		Yogurt	
	List-based	Wheel-based	List-based	Wheel-based
Easiness-to-perform	5.00 (1.57)	4.84 (1.66)	5.10 (1.37)	5.16 (1.45)
Tedious	3.00 (1.70)	3.02 (1.49)	3.04 (1.54)	3.10 (1.50)
Adequateness	5.00 (1.34)	5.12 (1.24)	5.20 (1.14)	5.28 (0.95)

3.3.2. Experiment 2: Comparison of CATA and RATA response formats

While consumers used more emotional terms during the RATA questionnaire for the chocolate study, the number of emotional terms used during the yogurt study was similar for both scaling variants (Table 3.5a). It might be that the RATA method only leads to a higher percentage of used emotional terms for certain food product categories.

Participants used a significantly higher number of sensory terms when answering the RATA variant compared to the CATA variant (Table 3.5b), confirming previous findings (Ares, Bruzzone*, et al.*, 2014). The higher frequency of used terms might be an indication that consumers engage satisfying strategies when answering CATA questions (Jaeger *et al.*, 2014). The RATA task might be demanding a greater cognitive effort discouraging such strategies which could explain a higher frequency of term use (Ares, Bruzzone*, et al.*, 2014).

Similar results were obtained for the discriminatory capability of both scaling techniques (Table 3.5c). Although Ares, Bruzzone*, et al.* (2014) concluded that RATA method tended to discriminate better compared to CATA method between food samples, they also concluded that the discriminatory ability is product dependent and for instance found no significant differences for sliced bread samples. While RATA can be seen as a task requesting a higher analytical cognitive involvement of the participants than CATA, the differences in emotional profiles are rather small. Therefore, the higher cognitive involvement from the RATA approach is unlikely to influence the main conclusions driven from the comparison of emotional profiles between food products.

No large differences in methodologies were found regarding the sample and term configurations as shown in the Table 3.5d. RV coefficients between the sample configurations in the first and second dimensions of the correspondence analysis from CATA and RATA questions reached values close to 1.00, indicating that samples configurations were highly similar. This was the case for both the emotional and sensory data and regardless if the frequency of use (RATA) or scores (RATA scoring) were used in the RATA variant. Although RV coefficients between term configurations were lower compared to those obtained from the sample configurations, they still reached significance in all cases. The resemblance between term and sample configurations suggests that participants used the terms in a similar way to describe the samples for both scaling methodologies. These findings corresponds to previous studies (Ares, Bruzzone*, et al.*, 2014; Reinbach, Giacalone, Ribeiro, Bredie, & Frøst, 2014).

Results obtained about the easiness of the task were similar for both scaling formats when using chocolate (CATA: mean = 4.7, S.D. = 1.7; RATA: mean = 4.6, S.D. = 1.6) and yogurt (CATA: mean = 4.7, S.D. = 1.7; RATA: mean = 4.7, S.D. = 1.8) products. These values are comparable with previous studies (Ares, Bruzzone*, et al.*, 2014; Schouteten *et al.*, 2015). The RATA format (mean = 2.6, S.D. = 1.5) was perceived as less tedious compared to the CATA format (mean = 3.0, S.D. = 1.4) during the chocolate study ($U = 1352.00$, $p = 0.045$). This is in contrast with (Ares, Bruzzone*, et al.*, 2014) who found that consumers perceived CATA questions as less

tedious than RATA questions when conducting sensory profiling. However, they report that effect sizes were of no practical significance. Further, the tediousness did not differ significantly between the CATA (mean = 2.8, S.D. = 1.5) and RATA scaling (mean = 3.0, S.D. = 1.7) if yogurt samples were studied (U = 1368.500, p = 0.403) suggesting that the perceived tediousness of the task might differ along product categories.

Table 3.5 Summary of results for the comparison of the emotional and sensory profiling using CATA and RATA scaling in the chocolate and yogurt study

	Chocolate		Yogurt	
	CATA (n = 58)	RATA (n = 59)	CATA (n = 51)	RATA (n = 54)
a. Hedonic liking				
Mean (S.D.)	C1: 7.2[a](1.0) C2: 6.7[a](1.6) C3: 5.0[b](1.6)	C1: 6.7[a](1.6) C2: 6.7[a](1.4) C3: 5.2[b](1.9)	Y1: 5.2(1.9) Y2: 5.4(1.9) Y3: 5.8(1.5)	Y1: 5.6(1.5) Y2: 5.7(1.7) Y3: 6.0(1.6)
b. Term usage				
Average percentage of emotional terms used to describe samples	14%[a]	19%[b]	15%	15%
Average percentage of sensory terms used to describe samples	30%[a]	36%[b]	25%[a]	37%[b]
c. Sample differences				
Number of emotional terms with significant differences among samples (p ≤ 0.05)	12	RATA: 12 RATA-S: 11	0	RATA: 2 RATA-S: 0
Number of sensory terms with significant differences among samples (p ≤ 0.05)	7	RATA: 6 RATA-S: 6	7	RATA: 8 RATA-S: 8
d. Sample configurations				
RV between sample configurations obtained from CA of emotion data from CATA and RATA questions	RATA: 1.00*** RATA-S: 1.00***		RATA: 1.00*** RATA-S: 0.99***	
RV between term configurations obtained from CA of emotion data from CATA and RATA questions	RATA: 0.68*** RATA-S: 0.71***		RATA: 0.83*** RATA-S: 0.79***	
RV between sample configurations obtained from CA of sensory data from CATA and RATA questions	RATA: 0.97*** RATA-S: 0.98***		RATA: 0.98*** RATA-S: 1.00***	
RV between term configurations obtained from CA of sensory data from CATA and RATA questions	RATA: 0.65* RATA-S: 0.57*		RATA: 0.94*** RATA-S: 0.94***	

CA = Correspondence analysis;

RATA: data were analysed by only taking the frequency of selection into account; RATA-S: data were analysed by creating a summed index of the scores provided by all participants for each of the terms of the question;

Samples with different superscript letter in the hedonic liking scores differ significantly within a questionnaire format (p ≤ 0.05);

RV score significance level: *, p ≤ 0.05; ***, p ≤ 0.001

3.3.3. Experiment 3: Influence of the EmoSensory® Wheel task on the concurrent hedonic assessment

The third experiment examined if performing the emotional and sensory profiling task, either with a CATA or RATA response format, could influence the concurrent hedonic assessment. Results found no evidence that the concurrent use of the EmoSensory® Wheel influenced the hedonic liking scores (Table 3.6). Also, the wheel-based questionnaire format did not affected the sample ranking in terms of overall liking as the experimental treatment x sample interaction effects were also not significant in any of the studies ($p \geq 0.064$). These outcomes are in line with previous findings which found that CATA questions applied for sensory profiling (Jaeger & Ares, 2014; Sara R. Jaeger *et al.*, 2013) or emotional profiling (King *et al.*, 2013) are unlikely to bias concurrent hedonic assessment. Our results also supported the findings of Jaeger and Ares (2015) indicating that sensory profiling using RATA questions is not likely to influence hedonic scores.

Table 3.6 The influence of the EmoSensory® profile task on hedonic scores, by linear mixed modelling (fixed effects: experimental treatment, sample, interaction experimental treatment x sample; random effect: consumer)

Study	Study description	Experimental treatments	Summary of results of linear mixed model	
Chocolate	19 emotional terms 14 sensory terms	Hedonic (n = 59) Hedonic + CATA (n = 58)	$F_{Exp.Tr} = 0.684$ $F_{Sample} = 52.081$ $F_{Exp.Tr * Sample} = 0.132$	p = 0.410 p < 0.001 p = 0.876
		Hedonic (n = 59) Hedonic + RATA (n = 59)	$F_{Exp.Tr} = 2.031$ $F_{Sample} = 44.571$ $F_{Exp.Tr * Sample} = 2.775$	p = 0.157 p < 0.001 p = 0.064
Yogurt	18 sensory terms 14 sensory terms	Hedonic (n = 59) Hedonic + CATA (n = 51)	$F_{Exp.Tr} = 2.212$ $F_{Sample} = 0.750$ $F_{Exp.Tr * Sample} = 1.580$	p = 0.140 p = 0.473 p = 0.208
		Hedonic (n = 59) Hedonic + RATA (n = 54)	$F_{Exp.Tr} = 0.352$ $F_{Sample} = 0.571$ $F_{Exp.Tr * Sample} = 0.738$	p = 0.554 p = 0.565 p = 0.479

Experimental treatments: hedonic indicates only hedonic assessment; hedonic + CATA indicates hedonic assessment and EmoSensory® Wheel using CATA response format; hedonic + RATA indicates hedonic assessment and EmoSensory® Wheel using RATA response format

3.4. Discussion

This chapter discusses the convergent validity (Carmines & Zeller, 1979) of the EmoSensory® Wheel by comparing the use of the wheel questionnaire format with a regular list-based questionnaire format for conducting the emotional and sensory profiling format. Further, two important methodological issues are addressed by comparing the use of two response formats (CATA and RATA) and investigating if the profiling task influences the concurrent hedonic assessment.

The first experiment showed that the consumers used a similar number of terms for conducting the profiling task. Although it is worth to mention that almost twice as much sensory terms were used compared to emotional terms, the number of terms was in line with those reported in previous research using list-based questionnaire formats (Ares, Bruzzone*, et al.*, 2014; King *et al.*, 2013; Piqueras-Fiszman & Jaeger, 2014a). Though the product category will certainly play a role, for instance more emotional terms were selected for the chocolate study compared to the yogurt study, it might be that the lower number of selection is due to the fact that some participants are less familiar with expressing their emotional conceptualisations (Jaeger, Cardello, & Schutz, 2013). The discriminatory ability of the EmoSensory® Wheel was in some cases slightly better compared to a list-based questionnaire format. The configuration of samples and terms were similar in the first two dimensions of the correspondence analysis for both the yogurt and chocolate samples, which also indicates that both tasks lead to similar answers. While participants perceived the easiness-to-perform, tediousness and adequateness of the task with both questionnaire formats more or less equal, a large majority of the participants preferred the wheel method.

Previous findings of Ares, Bruzzone*, et al.* (2014) reporting that participants use more terms for conducting a sensory profiling task when using the RATA format compared to the CATA format are confirmed in this study. However, emotional terms were only used more in the RATA-based chocolate experiment, but not in the yoghurt study, which suggests that the RATA effect of higher term usage might be product dependent when conducting emotional profiling. The higher term use frequency may indicate that the RATA method required greater cognitive effort than the CATA method in some cases, discouraging the use of satisfying response strategies by consumers (Ares, Bruzzone*, et al.*, 2014). In general, the RATA and CATA question formats yielded the same discriminatory ability for emotional and sensory terms for both the chocolate and yogurt study. The high similarity between term configuration from RATA and CATA questions was also relatively high and significant. In other words, participants used the sensory and emotional terms in a similar way for describing the samples in the studies. The same discriminatory ability and high agreement in term configuration between the CATA and RATA response format corresponds with previous findings on sensory profiling using a list-based questionnaire format (Ares, Bruzzone*, et al.*, 2014; Reinbach *et al.*, 2014).

When the EmoSensory® Wheel is applied using CATA or RATA response formats, it is unlikely that this task will influence the concurrent hedonic scores according to the results of the third

experiment with chocolate and yogurt samples. These findings are in line with other emotional and sensory profiling studies (Jaeger & Ares, 2014, 2015; King *et al.*, 2013). However, one should note that our experiments only targeted a limited number of product samples as suggested by King (2010). Research involving the emotional profiling of seven breakfast drinks, for example, has found that liking tended to decrease among the last presented samples (Gutjar, de Graaf*, et al.*, 2015). Therefore, the potential effect of number of samples on liking, as well on the emotional and sensory profiling deserves further investigation.

When looking at the general findings, the experiments indicate that sensory and emotional profiling could provide additional consumer insights, even when the liking of the products is similar, as in previous research (King & Meiselman, 2010; Schouteten *et al.*, 2015; Spinelli *et al.*, 2014). Further, one should note that only a limited number of emotional terms differed between the yogurt samples although the sensory profiles of the products clearly differed. This contradicts previous reports that emotions are mainly sensory-driven (Gutjar, Dalenberg*, et al.*, 2015; Ng, Chaya, & Hort, 2013b; Spinelli, Masi, Zoboli, Prescott, & Monteleone, 2015), but these conclusions were based upon the comparison of blind versus branded evaluation conditions. It could be that emotional conceptualisations of yogurt products are more linked to the product category instead of the individual products, which led to little discriminatory emotional terms. Hence, it could be of interest to investigate if the more realistic branded evaluation leads to more distinguished emotional profiles between food products as more information about a product might increase its hedonic liking (Skov & Perez-Cueto, 2015). Further, more research is needed with a wide variety of food product categories to examine if emotional measurements are little discriminatory for certain food categories.

Studies included in this chapter used emotional terms defined by consumers specifically for the products under study which tend to be more discriminating compared to a standard emotion list (Ng *et al.*, 2013a). It might be of interest to examine whether similar findings are obtained when working with a predefined emotional list such as the EsSense Profile™ (King & Meiselman, 2010). Standardized questionnaires reduce total project time and cost-efforts but have the disadvantage that they include more emotional terms. The higher number of emotional terms in standardized questionnaires is to ensure that no important terms are missed which leads to a larger completion time of the task (S. R. Jaeger *et al.*, 2013; Spinelli *et al.*, 2014). The total number of terms (emotion and sensory combined) in this study have been restricted based upon suggestions of Jaeger *et al.* (2015). Therefore, it could be of interest to examine if the results are confirmed when working with a more or less extensive term list.

All experiments took place in laboratory environment to ensure similar testing conditions between the different participants and studies. The potential setting and context influence should be taken into account when interpreting the obtained results. Not only has it been reported that emotional measurements can be influenced by the actual (Desmet & Schifferstein, 2008; Porcherot, Petit, Giboreau, Gaudreau, & Cayeux, 2015) or imaginary context (Piqueras-Fiszman & Jaeger, 2014a, 2014b, 2014c), also sensory profiles can be influenced by

the evaluation context (Edwards, Meiselman, Edwards, & Lesher, 2003; Köster, 2003). It remains unclear to which extent the same results would be obtained when testing would occur in a less-controlled but more realistic context like for instance home-use-test.

Product samples were presented with a 3-digit code without any additional information during the experiments. Although this is a common practice in the field of sensory research, it does not mimic the reality because extrinsic cues such as brand, package, claims influence food choice and the sensory evaluation (Piqueras-Fiszman & Spence, 2015; Skov & Perez-Cueto, 2015). Future research should explore to which extent an informed evaluation condition influence the sensory and emotional profiling when eliciting the overall liking of the product. Also, the experiments of this chapter worked with frequent product users what is recommended in emotional research with consumers (King & Meiselman, 2010). But it seems necessary for scientists and companies to involve non-users so one could obtain a better understanding about what really drives certain people to not consume or buy a product. Not only the inclusion of non-users could offer new insights, it might also be interesting to set up studies in which consumers with a different usage frequency are under study.

Overall, these results indicate that the EmoSensory® Wheel is a useful and promising method for conducting sensory and emotional profiling with consumers. Although the wheel questionnaire format yielded similar results compared to a list-based questionnaire format, a high majority preferred the tool for conducting the profiling task. Further, this chapter shows that the wheel questionnaire format obtains discriminating sensory profiling for both the CATA and RATA response formats. Both response formats have their advantages and one should consider the best response format given the specific research design. Lastly, this chapter demonstrates that the concurrent use of the EmoSensory® Wheel is unlikely to bias hedonic scores. This is of importance given the potential for combining sensory and emotional profiling with hedonic liking for product innovation and marketing.

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Part III

The role of information and context on consumers' food experience

Chapter 4

Influence of health-related labels on the emotional and sensory profiling of cheese

This chapter is based on:
Schouteten, J.J., De Steur, H., De Pelsmaeker, S., Lagast, S., De Bourdeaudhuij, I., & Gellynck, X. (2015). Impact of health labels on flavour perception and emotional profiling: a consumer study on cheese. *Nutrients,* 7(12), 10251-10268.

Abstract
The global increase of cardiovascular diseases is linked to the shift towards unbalanced diets with increasing salt and fat intake. This has led to a growing consumers' interest in more nutritionally balanced food products, which explains the growing number of health-related claims on food products (e.g. 'low in salt' or 'light'). Based on a within-subjects design, consumers (n=129) evaluated the same cheese product with different labels. Participants rated liking, saltiness and fat flavour intensity before and after consuming four labelled cheeses. Even though the cheese products were identical, inclusion of health labels influenced consumer perceptions. Cheese with a 'light' label had a lower overall expected and perceived liking compared to regular cheese. Although cheese with a 'reduced salt' label had a lower expected liking compared to regular cheese, no lower liking was found when consumers actual consumed labelled cheese. All labels also influenced the perceived intensities of the attributes related to these labels e.g. for example salt intensity for 'reduced salt' label. While emotional profiles of the labelled cheeses differed before tasting, little differences were found when actual tasting these cheeses. In conclusion, this chapter shows that health-related labels might influence the perceived flavour and emotional profiles of cheese products.

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4.1. Introduction

The frequency of heart disease and hypertension is increasing throughout the world and one of the reasons is a shift towards a more unbalanced diet which includes a higher salt and fat intake (Doyle & Glass, 2010; Hooper *et al.*, 2001; Mente, de Koning, Shannon, & Anand, 2009). Salt intakes in most high income countries far exceed the upper limit of 5 g/day defined by the World Health Organisation (WHO) (Monro, Mhurchu, Jiang, Gorton, & Eyles, 2015). As high salt intakes are linked to high blood pressure, the leading risk factor for early death (Lim *et al.*, 2012), reducing salt intakes is seen as one of the most worthy objectives for increasing public health worldwide (Drake, Lopetcharat, & Drake, 2011). Reducing dietary fat intake gathered scientific interest in the last decade as it is energy dense while fat has a rather limited effect on suppressing the appetite compared with protein or carbohydrate (Egger & Swinburn, 1997). Its reduction may help lowering the energy intake (Norton, Fryer, & Parkinson, 2013) and therefore prevent obesity which could lead to heart disease (Guh *et al.*, 2009; Van Gaal, Mertens, & De Block, 2006).

As a growing number of consumers are becoming more conscious with the health aspects of their diet (Guerrero *et al.*, 2009; Januszewska *et al.*, 2012; Kühne, Vanhonacker, Gellynck, & Verbeke, 2010), new food products have been developed which could address those needs and contain for instance less salt and fat. In order to better inform consumers of the improved composition and reformulation, these foods often contain front-of-pack labelling (i.e. reduced in salt, 'light',…). Companies specifically target health-conscious consumers by using such labels which are potentially related to positive health outcomes (e.g. losing weight, lowering blood pressure,…) in the thoughts of consumers. However, one drawback is that consumers often associate changes in a particular ingredient, like salt reduction, with negative changes in flavour. Liem, Toraman Aydin, and Zandstra (2012), for example, have found that the expected liking of soup was lower when the package also referred to salt reduction. A similar conclusion was made in a milk chocolate experiment where the expected liking decreased for 'reduced-fat milk'-labelled products (Norton *et al.*, 2013). While these and other studies (for a review, see Fernqvist and Ekelund (2014)), have shown that health-related claims could influence consumers liking of food products, it still remains to be investigated how the presence of such labels affects consumers' expectations and actual experience of more specific sensory attributes. Because the acceptance of food products with health-related labels are also known to correspond with consumers' attitudes and beliefs of such food products (Aaron, Mela, & Evans, 1994; Wansink & Park, 2002), it is crucial to understand the impact of health-related labels on consumers flavour perceptions in order to effectively promote healthy behaviour.

From a theoretical point of view, three concepts are important about the potential influence of labels on the subsequent perception: (1) priming, (2) expectation theory and (3) halo effect. The *priming theory* is initially developed in cognitive psychology (Schacter, 1987; Tulving & Schacter, 1990) and comprises two phases. Participants are exposed to a stimulus (also known as prime) which can belong to any sensory modality (e.g. olfactory, visual, auditory, flavour)

during the first phase. The exposure to the prime leads to the activation of mental representations of the prime (Shiffrin & Schneider, 1977). In a second phase, the unconscious effects are then evaluated as it is suggested that cues or primers can lead to the automatically activation of associated representations in memory increasing their accessibility (Chambaron, Chisin, Chabanet, Issanchou, & Brand, 2015; Forwood, Ahern, Hollands, Ng, & Marteau, 2015). As a consequence, Chambaron *et al.* (2015) state that exposure to a food-related stimulus (e.g., odour, message) may have important effects on subsequent eating behaviour. Recent literature even suggest that priming with for instance fruit advertisements could improve the healthiness of food choices (Forwood *et al.*, 2015). *Expectations research* has been widely applied in the field of food sensory and consumer research and examines the influence of information cues and expectations of those cues on the evaluation of food products. When one consumes a food or beverage, there may or may not be a disparity between the expected and actual experience. If such discrepancy occurs, a number of different outcomes could occur as reported in previous literature (Cardello, 1994; Cardello, 2007) and four main psychological theories have been developed in order to explain such disconfirmation: (1) assimilation effect takes place when the participant adjusts his or her perception to what was expected which results into the shift of product evaluation ratings in the direction of the participant's prior expectations; (2) contrast theory can be applied when a person magnifies the difference which lead to the product evaluation ratings shifting into the opposite direction; (3) generalised negativity effect occurs when a consumer evaluates a product negatively because the expectations that they had prior to the evaluation were not met and therefore always lead to a lower product evaluation rating; (4) assimilation / contrast theory depicts that assimilation will be observed if the disparity between the expected and experienced evaluation is rather small. If the discrepancy is too large, the contrast effect will likely occur instead. A recent review by Piqueras-Fiszman and Spence (2015) contains a broad overview of research on sensory expectations with several types of information (including health-related information like nutrition content) and concludes that it is mostly the assimilation/contrast model which is applicable when testing food products with health-related information. Lastly, a *halo effect* could take place. The halo effect involves cognitive bias when the assessment of one particular characteristic (e.g. health label) of an item (e.g. food product) strongly affects the perception of other attributes (e.g. fat flavour perception, colour intensity) of the same item (Apaolaza, Hartmann, López, Barrutia, & Echebarria, 2014). An example is a recent study by Sütterlin and Siegrist (2015) which found that using the label 'fruit sugar' instead of 'sugar' increased perceived healthiness of breakfast cereals.

It is also essential to measure beyond the overall acceptance of food products and obtain a broader perspective of consumers' food product experience, given the high product failure rates at market introduction (Cardello *et al.*, 2012; Thomson, Crocker, & Marketo, 2010). In the last years, assessing the emotional conceptualizations which consumers associate with food products have gathered momentum as a possibility to obtain additional information aside from the overall acceptance (Köster & Mojet, 2015). Several studies have illustrated that emotional

conceptualizations can discriminate between food products even if the overall acceptance between products is similar (King & Meiselman, 2010; Ng, Chaya, & Hort, 2013a; Spinelli, Masi, Zoboli, Prescott, & Monteleone, 2015). Moreover, recent research suggests that including emotional measurements significantly improves food choice prediction of common acceptance measurements (Dalenberg *et al.*, 2014). Thereby, emotions typically can be classified as 'positive', 'unclassified' or 'negative' (De Pelsmaeker, Schouteten, & Gellynck, 2013; King & Meiselman, 2010), which could provide additional possibilities in further understanding consumer attitudes and beliefs towards food choice.

More recently, a growing number of studies have been carried out where consumers instead of trained panellists performed sensory profiling of food products (Meiselman, 2013; Moussaoui & Varela, 2010). To ease and further improve the use of consumers for this kind of research, researchers have developed several new methodologies, such as check-all-that-apply, Napping® and flash profiling (Moussaoui & Varela, 2010; Varela & Ares, 2012). Most new methods appear to be more cost efficient than traditional sensory profiling methods performed with experts and allow to retrieve direct feedback from consumers (Moussaoui & Varela, 2010). When compared with traditional profiling, these methods were as successful to describe and quantify product differences (Moussaoui & Varela, 2010; Varela & Ares, 2012; Worch, Lê, & Punter, 2010).

The purpose of this study was twofold: (1) to examine the influence of potential health messages, like 'reduced salt content' and 'light', on the expected and perceived sensory evaluation of cheese; (2) to investigate which emotional conceptualizations consumers associate with such messages.

For this study, cheese was taken as a case. Cheese is an important source of dietary calcium, proteins and also vitamins (Keast, Fulgoni, Nicklas, & O'Neil, 2013; Lucas *et al.*, 2006; O'Neil, Keast, Fulgoni, & Nicklas, 2012). Although cheese consumption increases worldwide (Czarnacka-Szymani & Jezewska-Zychowicz, 2015), most cheeses have a rather high fat and salt content (Lucas *et al.*, 2006). Therefore, new cheese products have been launched to address health conscious consumers such as light cheeses (associated with a lower fat content) and low-sodium cheeses. Hence, this study aims to evaluate the effect of health-related labels on the expected and perceived flavour perception of cheese.

4.2. Materials and methods

4.2.1. Participants

Participants were recruited in Ghent area (Belgium) and no information about the aim of the study was provided at recruitment stage.

In total, 129 consumers participated in this test of which 53.4% were female. The mean participant age was 24.9 years (SD = 9.5), but participants ranged from 18 to 77 years. Additional data regarding place of living, educational level and monthly net income is listed in Table 4.1. More than 80% of the participants ate at least 2 to 3 times cheese a week. Subjects were not compensated for their participation in the study.

Table 4.1 Socio-demographic profile of the sample (n = 129)

Place of living	Urban: 21.7%
	Suburban: 27.9%
	Countryside: 50.4%
Educational level	Elementary school: 1.6%
	High school: 42.6 %
	University college: 9.3%
	University 46.5%
Net income	< € 500: 65.9%
	€500 -€999 : 1.6%
	€1000 - €1499: 3.1%
	€1500 - €1999: 17.8%
	€2000 - €2499: 6.2%
	€2500 - €2999: 1.6%
	≥ €3000: 0.8%
	Not willing to provide info: 3.1%

4.2.2. Materials

4.2.2.1. Cheese products

Each participant received two pieces of one cheese at the time (Boni selection Belgian young Gouda, purchased at Colruyt). All cheeses were exactly the same but different information was provided. A 3-digit random number was assigned to each sample and cheeses slices were 1.5 x 1.5 x1.5 cm (Santillo *et al.*, 2012). Samples were served one at the time at 13°C (Hersleth, Ueland, Allain, & Næs, 2005) on an odourless plastic plate.

4.2.2.2. Health-related labels and experimental design

To reduce the potential influence of a package (which includes, for example, brand and nutrient information), only a label description was included, in line with previous research on soy and organic labels (Lee, Shimizu, Kniffin, & Wansink, 2013; Wansink & Park, 2002). The control label simply mentioned 'cheese' (hereafter referred to as 'control label'). The three other health-related labels were: (1) 'cheese with reduced salt' (hereafter referred to as 'reduced salt label'), (2) 'light cheese' (hereafter referred to as 'light label') and (3) 'light cheese with reduced salt' 'hereafter referred to as 'light + reduced salt label'). Cheeses containing these labels were available in major retailer stores across Belgium at the time of the study.

The presentation of the four labels were counterbalanced using a Williams design (MacFie, Bratchell, Greenhoff, & Vallis, 1989) to avoid confounds associated when using a within-participant design, such as first order and carryover effects. All consumers evaluated all the four labels under the expected and informed conditions.

4.2.3. Evaluation procedure

The tests were conducted in the sensory lab of Ghent university. The respondents were told that they were going to evaluate four pieces of young Gouda cheeses and more detailed information about the cheese would follow when the evaluation started. This is comparable to the research of Liem *et al.* (2012) which worked with the same chicken soup while providing different health-related labels as information.

Before taking part in the study, potential participants were first required to complete a screening questionnaire in order to assess their suitability for the study. The screening criteria were based on their diet (consuming cheese products), food allergies (not lactose intolerant, no milk allergy or casein allergy) and their cheese consumption (at least once a month) (Lawless & Heymann, 2010; Meilgaard, Carr, & Civille, 2006).

The questionnaire comprised five parts and was computer-based using EyeQuestion v3.12.0 (Logic8 BV) software (Figure 4.1).

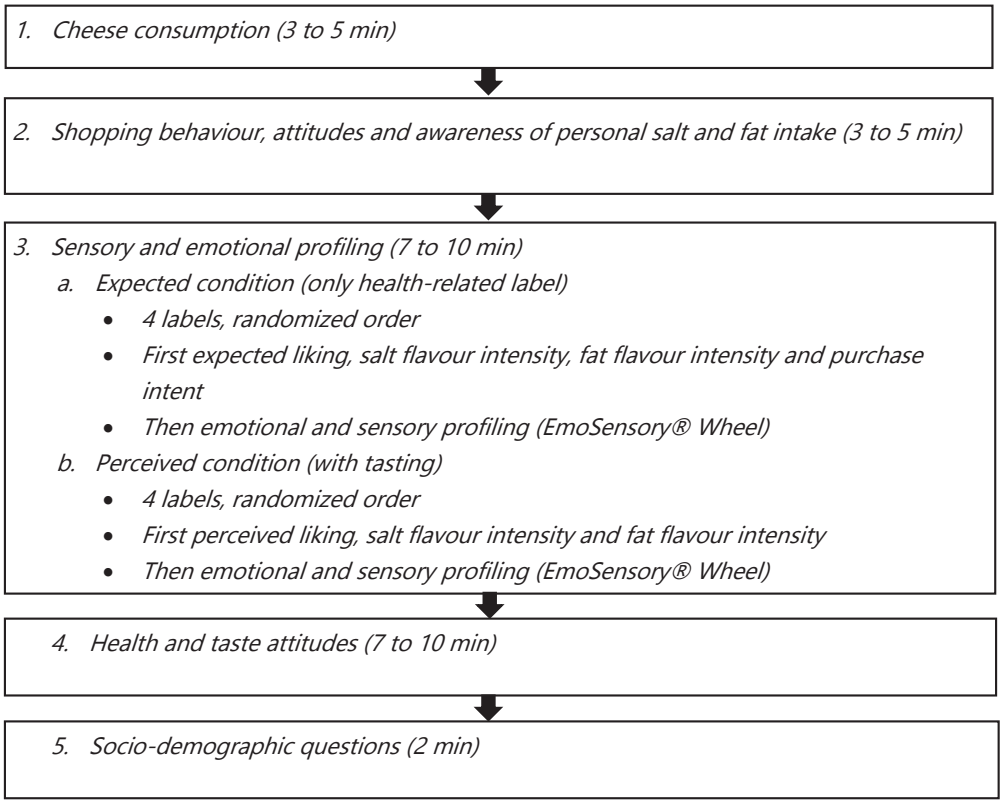

Figure 4.1 Questionnaire flow

The first part examined the *consumption of cheese* with questions based upon a focus group discussion, prior research and reviewing the literature. The frequency of consumption was examined by using 6 scale labels ranging from 'daily' to 'once a month'. Next, they indicated which type of cheese they consume followed by choosing their preferred type. Possible options were 'hard cheese', 'soft cheese', 'cream cheese', 'light cheese', 'goat cheese', 'blue cheese' or 'other'. If they chose ''other'', they could specify their answer.

Questions regarding the participants' *shopping behaviour, attitudes* and *awareness* of *personal salt and fat intake* were asked in the second part of the study. This makes a more detailed classification of the sample possible. Regarding salt labelling, *three yes/no questions* were asked to assess *shopping behaviour*, based upon previous research (Grimes, Riddell, & Nowson, 2009; Webster, Li, Dunford, Nowson, & Neal, 2010). First, participants were asked 'do you look for the salt content on food products when shopping?'. Next, they were asked if salt content influenced purchases and if they often buy food products labelled as reduced salt products. Further two items reflecting *awareness of personal salt intake* were included. Participants were asked to which extend they have a diet with a low or high salt intake using a

5-point scale ('very low in salt', 'low in salt', 'average salt intake', 'high in salt', 'very high in salt') (North & Neale, 1995). To evaluate consumers salt intake, respondents were asked to compare their salt intake to the intake of men / women of the same age on a 5-point scale ranging from 'much less' (1) to 'much more' (5). *Intention to consume less salt* in their diet was asked using three possibilities: 'no', 'yes, within 6 months' and 'yes, within one month'. Finally, one question asked if participants thought that they need to have a diet low in salt on most days of the week using a 5-point Likert scale ranging from 'strongly disagree' (1) to 'strongly agree' (5) to reflect their *attitude towards salt consumption*. Similar questions were asked about the fat e.g. '*Do you look for the fat content on food products when shopping*', '*Does salt content influence your food purchases*' and '*Do you often buy low-fat labelled food products?*. Also, participants reported to which extend their *diet contains fat* using a 5-point scale ('very low in fat', 'low in fat', 'average fat intake', 'high in fat', 'very high in fat') (Brug, van Assema, Kok, Lenderink, & Glanz, 1994; De Bourdeaudhuij, Brug, Vandelanotte, & Van Oost, 2002). Further, respondents were asked to *evaluate* their *fat intake compared* to a *men/women* of a *similar age* on a 5-point scale ranging from 'much less' (1) to 'much more' (5). Intention to consume less fat was questioned using the options 'no', 'yes, within 6 months' and 'yes, within one month'.

In the third part, participants' *expectations* of the *salt intensity*, *fat flavour intensity* and *desire* of the four labelled cheeses were assessed. The labels were given in a random order to avoid order bias and carry-over effects (MacFie *et al.*, 1989). Thereby, specific questions include: (1) How much do you think you will like the cheese, (2) 'How salty do you think this cheese taste', (3) 'How fatty do you think this cheese will taste' and (4) 'How much do you want to taste this cheese'. These questions were based upon Liem et al. (2012) and bipolar 7-point scales were used (i.e. 1= extremely dislike – 7= extremely like, 1 = not salty at all – 7 = extremely salty, 1 = not fatty at all – 7 = extremely fatty, 1 = do not want at all and 7 = want extremely). Also, recent work suggests that fat flavour is a basic taste (Keast & Costanzo, 2015; Running, Craig, & Mattes, 2015). Next, consumers assessed the *emotional conceptualizations* and *sensory terms* which they associate with each cheese. Product specific emotional and sensory terms were determined during preliminary research following a two-step approach suggested by Ng *et al.* (2013a) and Ares, Barreiro, Deliza, Giménez, and Gambaro (2010). First, a small group of consumers evaluated a list of emotional and sensory terms based upon previous studies (Desmet & Schifferstein, 2008; King & Meiselman, 2010; Laros & Steenkamp, 2005; Mcewan, Moore, & Colwill, 1989; Salles *et al.*, 1995; Szczesniak, 2002; Thomson & Crocker, 2013). The consumers also had the possibility to add their own terms and a focus group was held to see if additional terms were generated. Second, a final selection was made based on the number of people selecting the terms (≥15%) and the ability of the terms to discriminate between food products into account (De Pelsmaeker *et al.*, 2013; Ferrarini *et al.*, 2010; Manzocco, Rumignani, & Lagazio, 2013; Ng, Chaya, & Hort, 2013b; Thomson *et al.*, 2010). In addition, a balance between positive and negative emotions was made to easily compare the emotions and provide a global overview (De Pelsmaeker *et al.*, 2013; Desmet & Schifferstein, 2008). Sensory terms were selected to cover multiple sensory modalities (appearance, aroma, flavour, texture,

aftertaste) (Ares *et al.*, 2014). An overview of the selected terms is listed in Table 4.2. As suggested in previous research with emotional terms (Ng *et al.*, 2013a), a rate-all-that-apply scale was used when the consumers evaluated the products during the consumer test. This scale has also been applied for the sensory profiling of several food products (Ares *et al.*, 2014; Jaeger & Ares, 2015). Participants used this scale to rate the intensity of the applicable sensory and emotional terms with a wheel format (EmoSensory® Wheel) using a 5-point scale with end-point anchors 1 = 'slightly' to 5 = 'extremely'. Terms were given in alphabetical order as this does not influence the results, compared with a randomized presentation order (Ares & Jaeger, 2013; King, Meiselman, & Carr, 2013).

After the participants expressed their expectations during the label only treatment, they received one cheese at the time to perform the perceived treatment. Participants were instructed to consume a first piece of cheese and rate (1) the overall liking, (2) salt flavour intensity and (3) fat flavour intensity of the cheese product using a 7-point bipolar scale (i.e. 1= extremely dislike – 7= extremely like, 1 = not salty at all – 7 = extremely salty, 1 = not fatty at all – 7 = extremely fatty). Next participants were asked to rate the intensity of the applicable sensory and emotional terms with the following instruction: '*Please try cheese sample XXX. Then, tick on each word that applies to describe cheese XXX and rate the intensity. Also, rate the intensity of applicable words which describe how you feel right now.*' This instruction was based upon previous work for the sensory (Jaeger *et al.*, 2013) and emotional profiling (King & Meiselman, 2010) of food products. Lastly, consumers were asked to write down any remarks they had about the cheese products.

In the next part, several statements were included derived from the work of Roininen and Tuorila (1999) to gain more information about the health and taste interests of the participants. As these statements are beyond the scope of this chapter, this is mentioned for the sake of completeness but these are not discussed in further detail.

The last part contained several questions regarding the socio-demographic status of the respondents, such as age, gender, education level and place of residence.

Table 4.2 Overview emotional and sensory terms used in the EmoSensory® Wheel

Emotional terms	Sensory terms
Glad^{+}	Dry
Enthusiastic^{+}	Yellow
Irritated^{-}	Firm
Happy^{+}	Grainy
Good^{+}	Aftertaste
Calm^{u}	Pungent
Unpleasant surprise^{-}	Untasty
Discontented^{-}	Creamy
Disinterested^{-}	Soft
Dissatisfaction^{-}	Salty
Pleasant^{+}	Acid
Disappointed^{-}	
Merry^{+}	

$^{+,-,u}$ means positive/ negative / unclassified classified emotion

4.2.4. Data analysis

Repeated measures ANOVA and Bonferroni post-hoc analyses were carried out to examine whether labels lead to different expectations regarding overall liking, salt intensity, fat flavour intensity and desire. The same analyses were performed after tasting the labelled cheese (perceived condition).

As suggested by Ares *et al.* (2014), data obtained for the emotional and sensory characterization were analysed using two different approaches, i.e. frequency of selection or weighted frequency of selection (RATA scoring). RATA scorings take the actual points of the scale (ranging from 1 to 5) into account. Next, RATA scores for each emotional and sensory term were calculated by summing up the points. Cochran's Q test was performed to determine significant differences in the frequency of term selection among the labels in both expected and perceived condition. Friedman's test was carried out to identify significant differences in RATA scoring between the terms in either the expected or perceived condition. Further, repeated measures ANOVA with Bonferroni correction was performed to examine differences between the quantities of positive/negative emotions between the labels using sums of the frequency of term selection.

PCA analysis was performed on the data matrix containing the mean intensity scores for the emotional and sensory terms separately of each labelled sample informed condition. XLSTAT Version 2016.03.30882 was applied for the PCA analysis which was performed on both the expected and perceived condition.

Power analysis was conducted using GPower 3.1 (Faul, Erdfelder, Lang, & Buchner, 2007) and tests which obtained a significant p-value ($p \leq 0.05$) have a satisfactory power value above the threshold of 0.80. A 5% significance level ($p \leq 0.05$) was considered for all tests, except when stated otherwise.

4.3. Results

4.3.1. Cheese consumption, shopping behaviour, attitudes and awareness of personal salt and fat intake

4.3.1.1. Cheese consumption

Most participants consumed cheese several times during a regular week. The participants are fond of hard and soft cheeses while a lot of the participants also ate goat cheeses. Light cheeses are only consumed by around a quarter of the sample. Almost half of the sample preferred hard cheeses, while around 15 % of the respondents preferred creamy and goat cheeses (Table 4.3).

Table 4.3 Cheese consumption and preferences of the sample (n=129)

Consumption (%)		*Consumption of cheeses (%)*		*Preference (%)*	
Once a month	3.9	Soft cheese	72.1	Soft cheese	11.6
Once a week	14.7	Hard cheese	88.4	Hard cheese	47.3
2 to 3 times a week	27.1	Creamy cheese	63.6	Creamy cheese	14.0
4 to 6 times a week	25.6	Light cheese	26.4	Light cheese	0.8
Daily	28.7	Goat cheese	67.4	Goat cheese	16.3
				Other	0.8

4.3.1.2. Salt content

Only 3% of the respondents state that they look to the salt content when buying products and a little bit over 2% declares that they often bought food products with a reduced salt content. A high majority (88.4%) of the sample does not see the salt content as a reason not to buy a food product. Given these numbers, it is not a surprise that over 90% of the participants is not planning to consume less salt in their diet. When asking for the consumers awareness of their salt intake, ranging from very low in salt to very high in salt, over half of the respondents answer that they have an average salt intake in their diet (Figure 4.2). If the participants need to compare their salt intake to those of their peers (same gender and similar age), most respondents indicated that they have a similar salt intake like their peers. Lastly, more than one fourth of the participants found that they need to have a diet low in salt during most days in a week.

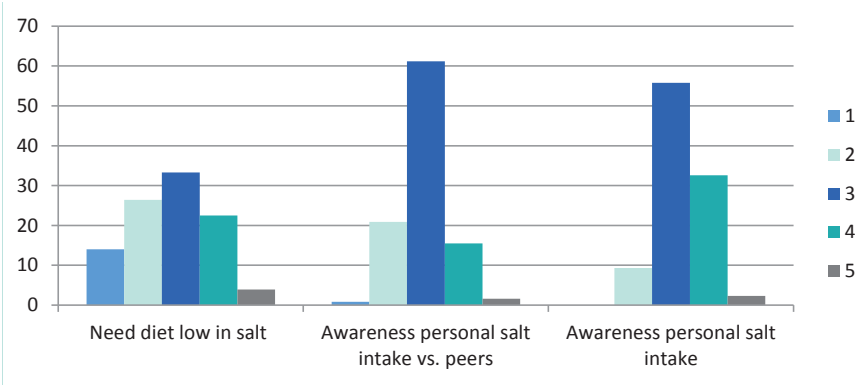

Figure 4.2 Respondents (in %) awareness of personal salt intake (very low in salt (1)- very high in salt(5)), awareness of personal salt intake compared with peers (consume much less salt (1) – consume much more salt (5)) and if they need a low-salt diet (totally disagree (1) – totally agree (5))

4.3.1.3. Fat content

Roughly one third of the respondents (36.4%) declared that they have a look at the fat content when buying food products. Just over 51% of the participants stated that fat content can be a reason to not buy a certain food product. Also, 31.8% of the respondents often bought low-fat products. In total, 30 % of the participants were planning to consume more products with a lower fat content in the next 6 months. Even 17% of the total sample indicated that they are planning to consume less products with a lower fat content during the next month. Most participants estimated that their diet is rather average on fat intake and that the total fat intake is comparable with the mean intake of males / females of the same age (Figure 4.3). Almost half of the people answered that they should have a low-fat diet on most days.

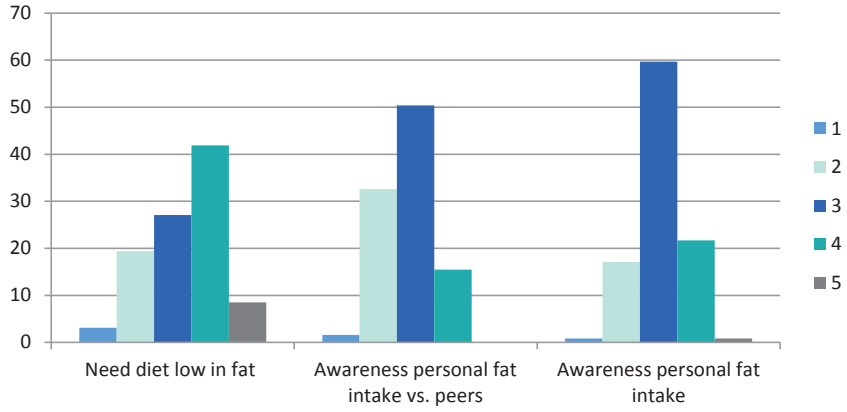

Figure 4.3 Respondents (in %) awareness of personal fat intake (very low in fat (1) - very high in fat(5)), awareness of personal fat intake compared with peers (consume much less fat (1) – consume much more fat (5)) and if they need a low-fat diet (totally disagree (1) – totally agree (5))

4.3.2. Liking, salt intensity, fat flavour intensity and desire

4.3.2.1. Expected condition

A significant main effect of labels on the expected liking ($F(2.803, 358.788) = 81.846$, $p < 0.001$), salt intensity ($F(2.712, 347.167) = 101.478$, $p < 0.001$), fat flavour intensity ($F(3, 384) = 90.889$, $p < 0.001$) and desire ($F(2.738, 350.512) = 42.265$, $p < 0.001$) was found (Table 4.4).

Figure 4.4 panel A shows that the expected liking of the 'control label' (5.26 ± 0.87) was significantly higher compared to the other labels. The mean expected liking of the 'light label' (4.05 ± 1.14) was significantly higher compared to the 'light + reduced salt' label (3.6 ± 1.18, $p < 0.001$), while it did not differ with the 'reduced salt' label (3.9 ± 1.07, $p = 1.0$).

The expected salt intensity differed significantly among all labels (Figure 4.4 panel B). The lowest mean salt intensity was expected with the 'reduced salt' label (2.35 ± 0.97). The expected salt intensity was the highest for the 'control label' cheese (4.30 ± 1.01). Overall, participants expected that the cheese with 'light + reduced label' would have a salt intensity (3.01 ± 1.14) significantly higher compared to the 'reduced salt label'($p < 0.001$) but lower than the 'light label' cheese (3.70 ± 1.14 ,$p < 0.001$).

The expected fat flavour intensity was significantly lower for the 'light label' (2.75 ± 1.04) compared to the other three labels (Figure 4.4 panel C). Participants expected that the fat flavour intensity of the 'reduced salt label' cheese (3.91 ± 1.05) would be lower compared to the regular, 'control label' cheese (4.37 ± 0.89, $p < 0.001$). The mean expected fat flavour intensity of the 'light + reduced salt label' cheese (4.02 ± 1.42) did not differ significantly between those latter two labels, but was significantly higher compared to the 'light label' cheese ($p < 0.001$).

Consumers mainly showed a desire for the 'control label' cheese, as its expected desire was 5.16 ± 1.03. This expected desire was significantly higher compared to the other three labels (vs. light label 4.14 ± 1.32, $p < 0.001$; vs reduced salt label 4.49 ± 1.24, $p < 0.001$; vs. light + reduced salt label 4.0 ± 1.42, $p < 0.001$). The mean expected desire for the 'reduced salt label' cheese was significantly higher compared to the 'light label' ($p = 0.003$) and 'light + reduced salt label' ($p < 0.001$). No significant main effect of the label was found on the expected desire between the 'light label' and the 'light + reduced salt label'.

4.3.2.2. Perceived condition

When participants evaluated the same cheese products but provided with different labels, significant differences were found for the perceived liking ($F(3, 384) = 8.518$, $p < 0.001$), salt intensity ($F(3, 384) = 16.655$, $p < 0.001$) and fat flavour intensity ($F(3, 384) = 21.671$, $p < 0.001$) (Table 4.4).

The highest perceived liking was for the cheese with the 'control label' (5.07 ± 1.20) which was significantly higher compared to the 'light label' (4.47 ± 1.32, $p < 0.001$) and 'light + reduced salt label' (4.45 ± 1.42, $p < 0.001$). Consumers tend to like the 'reduced salt label' (4.77 ± 1.35) as much as the 'control label', as no significant differences were found in the overall acceptance between both labels ($p = 0.248$). Further, the mean consumer liking between the 'light label' and 'light + reduced salt label' cheeses were very similar ($p = 1.0$) (Figure 4.4 Panel D).

When the cheese was provided with the 'control label', consumers tended to rate it more saltier (4.04 ± 1.25) compared with when it had another label. If a 'reduced salt label' was given, the perceived salt intensity (3.16 ± 1.41) was significantly lower compared to the 'control label' ($p < 0.001$) and 'light label' (3.60 ± 1.16, $p = 0.012$). There was no main effect of the label on the perceived salt intensity between the 'reduced salt label' and 'light + reduced salt label' (3.42 ± 1.42, $p = 1.0$). Also, no significant effect of the labelling on the saltiness perception was found between the 'light label' and 'light + reduced salt label' ($p = 0.072$) (Figure 4.4 Panel E).

Regarding the perceived fat flavour intensity, the labels could be divided in two groups. When the cheese was provided with a 'control label' (4.28 ± 1.13) or 'reduced salt label' (4.02 ± 1.24), the perceived fattiness was significantly higher compared with the same cheese labelled as 'light label' (3.40 ± 1.22) or 'light + reduced salt label' (3.53 ± 1.17) (Figure 4.4 Panel F).

Table 4.4 Significant differences between expected and perceived treatment for liking, salt and fat flavour intensity (n = 129). The levels for the ANOVA were the different labels ('control', 'light label', 'reduced salt label' and 'light + reduced salt label')

	F	df	p	η^2
Expected liking	81.846	2.803,358.788	<0.001	0.610
Expected salt flavour intensity	101.478	2.712,347.167	<0.001	0.728
Expected fat flavour intensity	90.889	3,384	<0.001	0.667
Perceived liking	8.518	3,384	<0.001	0.155
Perceived salt flavour intensity	16.655	3,384	<0.001	0.255
Perceived fat flavour intensity	21.671	3,384	<0.001	0.338

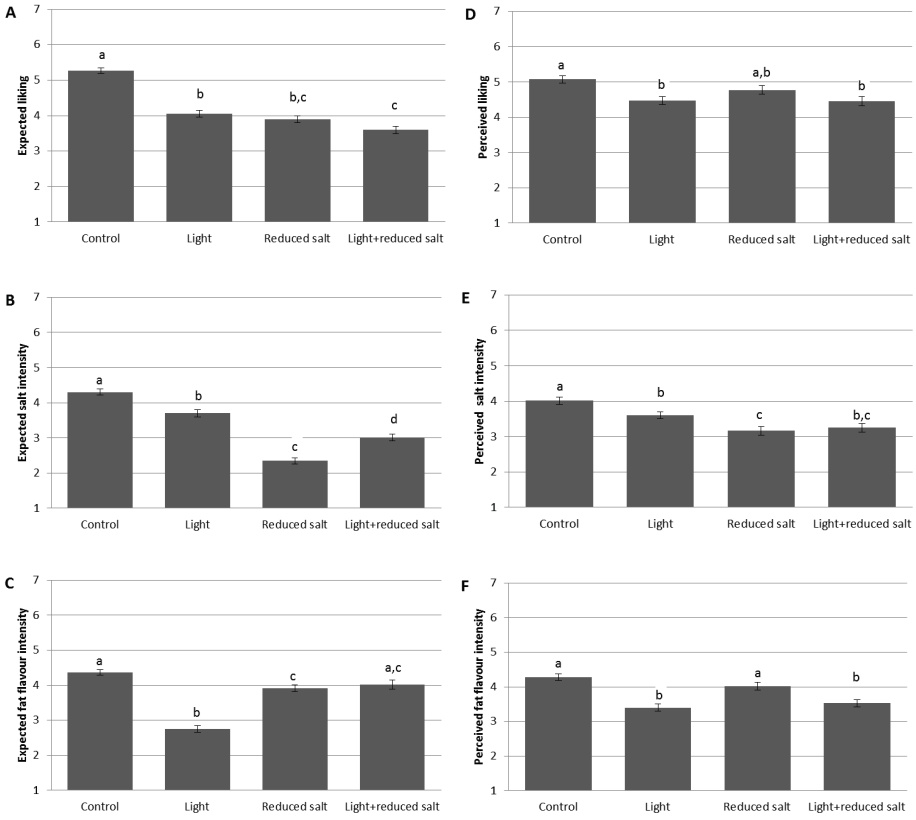

Figure 4.4 Expected liking (A); expected salt intensity (B); expected fat flavour intensity (C); perceived liking (D); perceived salt intensity (E) and perceived fat flavour intensity (F) of cheese with different labels (mean + SEM). Bars within a panel with the same letters do not differ significantly ($p \leq 0.05$).

4.3.3. Emotional and sensory profiling

4.3.3.1. Expected condition

Results related to frequency of use of both emotional and sensory terms are shown in Figure 4.5. Significant differences for the frequency of use between the differences labels were found for all emotions, except for the neutral emotion 'calm' (Q = 1.892, p = 0.595). Consumers also expect differences on the sensory level between the different labelled cheeses as significant differences for 8 out of 11 sensory attributes were found. When taking the actual scores into account for the analysis (RATA scoring), the same significant differences were found as when looking at the frequency of use. However, the RATA scoring approach lead to a higher significance level for three terms: 'unpleasant surprise' (p < 0.001 vs p = 0.001), 'dry' (p = 0.001 vs p = 0.004) and 'salty' (p < 0.001 vs. p = 0.003). Figure 4.6a shows the differences in intensities of emotional conceptualisations for the different labelled samples under the expected condition. Similar to the results of other scholarly studies (Gutjar *et al.*, 2015; Ng *et al.*, 2013a), the first dimension is related to the valence of the emotional conceptualisations. Only the sample of the control labelled cheese is associated with positive emotions in this biplot, those with health-related label are all located near negatively valenced emotional conceptualisations. The biplot (Figure 4.6b) shows that consumers expected mainly differences regarding sensory attribute intensities between on one hand the control labelled cheese and on the other hand the samples with health-related labels.

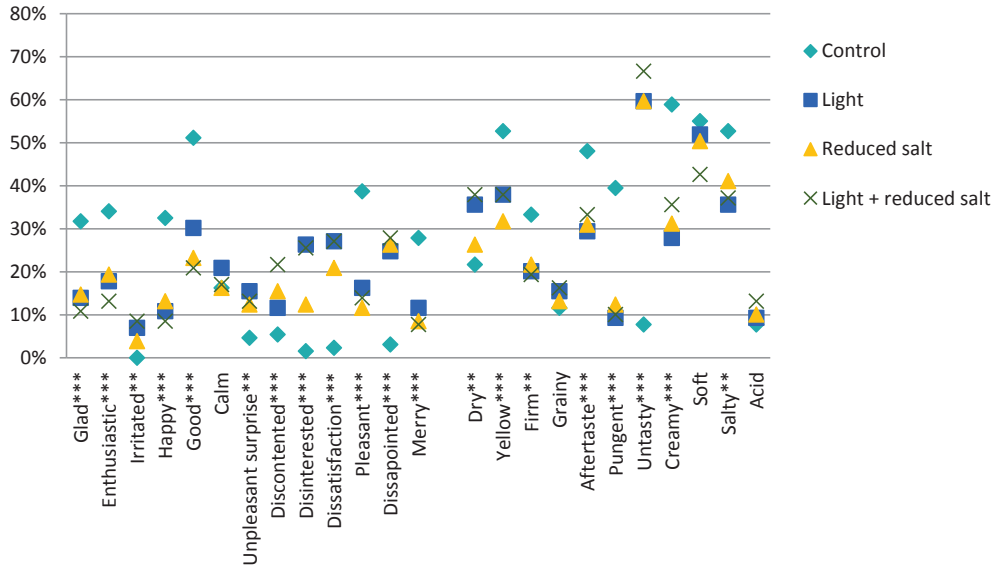

Figure 4.5 Expected emotional and sensory profiles of the four labelled cheeses
,* indicate significant differences at p ≤ 0.01, 0.001

If the valence of emotion (positive, negative or unclassified) is taken into account, the labels could be divided into 3 groups. The results show that the control label tend to be associated

more with positive emotions like glad, happy and enthusiastic compared to the other labels. The other labels are also largely associated with negative emotions in both the frequency of use and rata scoring approach. A distinction between the reduced salt label and the two other labels (light label and light + reduced salt label) could further be made. Consumers have a more positive feeling about the reduced salt label compared to the other two labels, as can be seen in Figure 4.5. Repeated measures ANOVA revealed that there are indeed significant differences in association of positive ($F(2.709, 346.802) = 60.909$, $p < 0.001$) and negative emotional conceptualizations ($F(3, 384) = 38.850$, $p < 0.001$) between the labels. Consumers checked significantly more positive emotional terms with the control label (2.1) compared to the other three labels (reduced salt label: 1.0 ($p < 0.001$), light label: 0.9 ($p < 0.001$) and light + reduced salt label: 0.8 ($p < 0.001$)). No significant differences in the association of positive emotional terms were found between the three health-related labels. Consumers tended to associate almost no negative emotions to the regular cheese as a mean term selection of only 0.2 emotional terms was found. This was significantly less compared to the three health-related labels. The 'light + reduced salt label' (1.2) had the highest association with negative emotions, which was significantly more compared to the 'reduced salt label' (0.9, $p = 0.011$) but did not differ significantly with the 'light label' (1.1, $p = 1.0$).

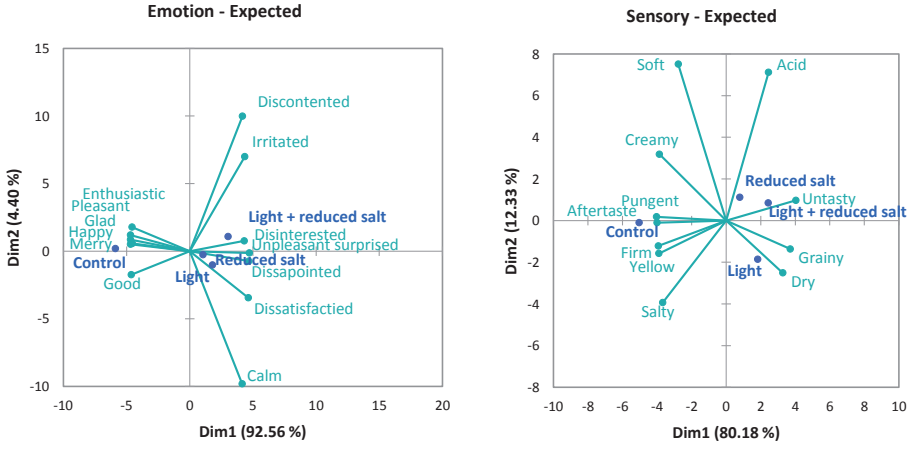

Figure 4.6 Biplots of the emotional (a) and sensory (b) terms associated with the labelled cheeses under the expected condition

4.3.3.2. Perceived condition

When consumers actually tasted the labelled cheese products, few significant differences were found in the association with emotional and sensory terms (Figure 4.7). Significantly more consumers indicated that the emotional term 'glad' was applicable to the control labelled cheese, compared to the health-related labelled cheeses. Surprisingly, although consumers evaluated the same cheese but accompanied with different labels, significant differences in term usage were found for the sensory terms 'creamy' ($Q = 18.290$, $p < 0.001$), 'salty' ($Q = 8.946$, $p = 0.030$) and 'untasty' ($Q = 15.707$, $p = 0.001$). Analysing the data using the RATA scoring approach revealed additional differences in the sensory perception of the evaluated labelled cheese. Consumers perceived differences in the intensity of the 'aftertaste' (χ^2 (3) = 7.994, $p = 0.046$) and 'yellow' (χ^2 (3) = 15.060, $p = 0.002$) between the four samples of labelled cheese. Regarding the emotionally loaded terms, only a significant difference was reported for the emotion 'glad' when taken the intensity into account. Biplots show that the product configurations are more scattered around the first two dimensions of the emotion (Figure 4.8a) and sensory (Figure 4.8b) plot under the perceived condition whereas the health-labelled samples were closer to each other under the expected condition (Figure 4.6a,b).

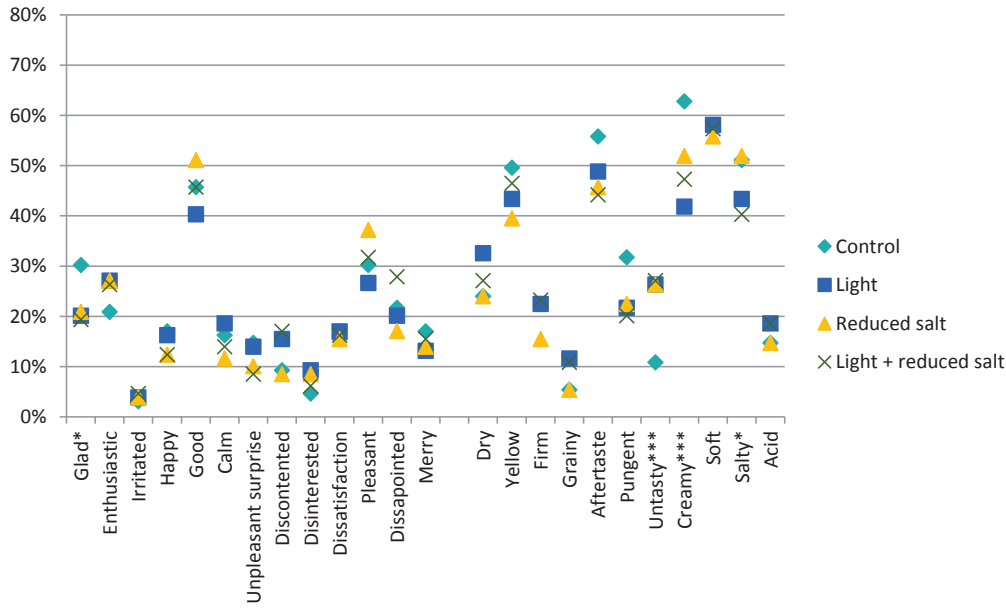

Figure 4.7 Perceived emotional and sensory profiles of the four labelled cheeses
*,*** indicates significant differences at $p \leq 0.05$, $p \leq 0.001$

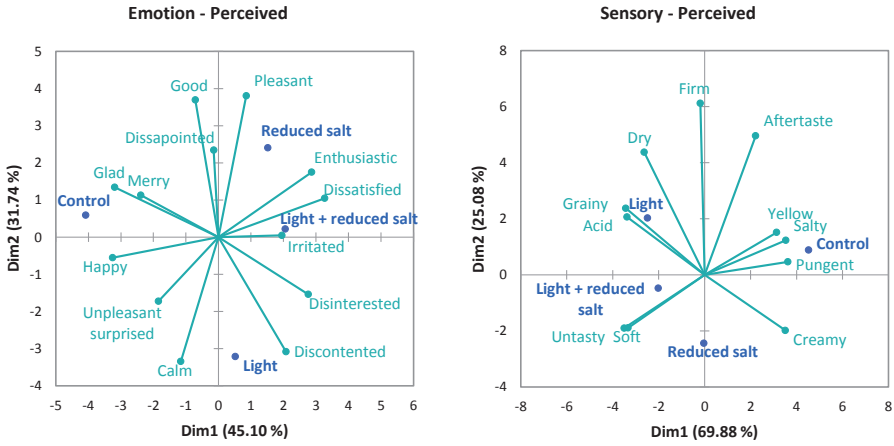

Figure 4.8 Biplots of the emotional (a) and sensory (b) terms associated with the labelled cheeses under the perceived condition

Regarding the valence of emotions associated with the labelled cheeses, no significant differences were found for either positive ($F(3, 384) = 0.607$, $p = 0.611$) or negative ($F(3, 384) = 0.976$, $p = 0.404$) emotional terms under the perceived condition. An overview of the mean liking and the differences in the emotional and sensory profiles is listed in Table 4.5.

Table 4.5. Summary of the differences of emotional and sensory terms during expected and perceived condition

Expected condition	
Emotional terms with significant differences between samples	RATA: disappointed***, discontented***, disinterested***, dissatisfied***, enthusiastic***, glad***, good***, happy***, irritated***, merry***, pleasant***, unpleasant surprise**
	RATA scoring: disappointed***, discontented***, dissatisfied***, enthusiastic***, glad***, good***, pleasant***, happy***, irritated**, merry***, unpleasant surprise**
Sensory terms with significant differences between samples	RATA: aftertaste***, dry**, creamy***, firm**, pungent***, salty**, untasty***, yellow***
	RATA scoring: aftertaste***, dry***, creamy***, firm*, pungent***, salty***, untasty***, yellow***
Perceived condition	
Emotional terms with significant differences between samples	RATA: glad*
	RATA scoring: glad***
Sensory terms with significant differences between samples	RATA: creamy***, salty*, untasty***
	RATA scoring: aftertaste*, creamy***, salty**, untasty***, yellow**

*,**,*** indicates significant differences at $p \leq 0.05$, $p \leq 0.01$, $p \leq 0.001$

4.4. Discussion

This study illustrated that health labels can influence consumers' flavour expectations of cheese. Several studies have found that health-related information like fat content (Ebneter, Latner, & Nigg, 2013; Engell, Bordi, Borja, Lambert, & Rolls, 1998; Kähkönen, Hakanpää, & Tuorila, 1999; Norton *et al.*, 2013), salt content (Liem *et al.*, 2012), health logo (Liem *et al.*, 2012), cholesterol reducing (Kihlberg, Johansson, Langsrud, & Risvik, 2005) and nutrition labels (Bayarri, Carbonell, Barrios, & Costell, 2010; Carrillo, Varela, & Fiszman, 2012; Ebneter *et al.*, 2013) could alter consumers' expected acceptance of food products.

In the current study, the expected liking of any health-related label (light or reduced salt or light + reduced salt label) was significantly lower compared to the control labelled cheese. Although food producers are using front of packaging labelling to communicate health-related credence attributes to consumers (Hawley *et al.*, 2013), they should be aware that taste-oriented consumers could interpret these labels as a warning sign regarding their flavour (Liem *et al.*, 2012). Previous research suggest that a large group of consumers tend to associate healthy food with a lack of taste (Verbeke, 2006) and the use of specific health related labels like 'light' could have a negative connotation and be more associated with 'light in taste' than for instance 'light in fat content' (Viaene, 1997). This negative effect of health labels on the expected liking could discourage taste-oriented consumers to even try or buy the product (Liem *et al.*, 2012). The lower negative expectations towards the health-related cheeses are not only limited to the expected liking, salt intensity and fat flavour intensity but is also reflected in the emotions consumers associate with these labelled cheeses. To date, few studies have examined the inclusion of emotional measurements next to overall acceptance during an expected condition. This study found that participants associate more negatively valenced emotions to these health-related labelled cheeses compared to the control labelled cheese during the expected condition and also less positive emotions compared to the control labelled cheese. The current study illustrates the added value of including emotional measurements next to overall liking during an expected condition as suggested by Spinelli *et al.* (2015).

When participants consumed the same cheese, significant differences were not only found for the overall liking but also on the level of salt intensity and fat flavour intensity. These results demonstrated that a health halo effect could have occurred when providing health-related information and confirm previous research results which also describes a health halo effect (Gravel *et al.*, 2012; Liem *et al.*, 2012; Sütterlin & Siegrist, 2015). A number of studies have concluded that health-related labels could influence acceptance of food products as discussed extensively in a review by Fernqvist and Ekelund (2014). But one should note that consumers did actually evaluated the same cheese product during this study which was also the case in the study of the study with chicken soup of Liem *et al.* (2012). Although Liem *et al.* (2012) did not found any influence of health labels on the flavour perception, in contrary to their hypothesis, they pointed out that the differences in acceptance between the expected and informed conditions were rather low. The perceived scores for the light and light + reduced

salt labelling are significant lower compared to the control label cheese. For these two labels, an assimilation effect occurs as participants liking tend to go in the direction of their expected liking. As only around one quarter of the consumer sample consumes light cheese, it could be that most consumers are not fond of light cheese or have rather negative experiences with light cheese (or light products in general). Further, no significant difference was found for the overall liking between the control labelled cheese and the reduced salt labelled cheese in the current study. This is in accordance with recent research of Czarnacka-Szymani and Jezewska-Zychowicz (2015) who found that labels containing the salt content did not alter consumers' acceptance of several salt reduced cheeses. It seems that the respondents of this study have a more positive attitude towards this label compared to the 'light label' and 'light + reduced salt label' when they actually consumed labelled cheese. One reason could be that participants are less familiar with the reduced salt label (which is suggested by the fact that only 3% looks to the salt content on a package) and a disconfirmation effect occurred. Participants may think that a reduced salt labelled cheese does not taste good which can be seen in the rather low expected acceptance in this study. When they actually consumed the cheese, it disconfirms these prior expectations and they tend to overcompensate as illustrated in another experiment with healthy labelled entrees and desserts with diet labels (Wansink, Ittersum, & Painter, 2004). In the case of the reduced salt label, the observed disconfirmation effect is considered to be a contrast effect. Further, the results of the perceived condition should be seen in the light of the priming theory and the presented results suggest that health-related labels might be used as a prime to guide people to make more healthier food choices. However, one should note that recent research suggest that the potential effect of health-related priming depends on individual traits like educational level and hunger states (Forwood *et al.*, 2015), so one need to bear this in mind when interpreting our results. A more specific research design would be needed when aiming to examine real behavioural outcome effects (e.g. ad libitum intake) of using health labels as primers and this yields an interesting potential for future research.

As only one out of fourteen emotional terms differed significantly during the tasting, this study illustrates that health-related information has little impact on the emotional profiling when consumers are actually consuming the same product. Previous research found that differences in emotional profiles of food products are primarily sensory driven (Chrea *et al.*, 2009; Gibson, 2006; King & Meiselman, 2010; Ng *et al.*, 2013a, 2013b; Porcherot *et al.*, 2012; Porcherot *et al.*, 2010; Spinelli *et al.*, 2015; Thomson *et al.*, 2010) and the current study support these findings. Nevertheless, it is remarkable to note that labelling also influences the flavour perception of the sensory attributes 'creamy', 'salty', 'untasty'. This confirms previous research where information altered the intensity perception of sensory attributes (Stolzenbach, Bredie, Christensen, & Byrne, 2013; Vidal, Barreiro, Gómez, Ares, & Giménez, 2013). While 'untasty' can be seen as a more hedonic oriented sensory attribute, 'creamy' and 'salty' are definitely linked to the health-related labels that were used in this study. Using those labels could possibly draw the attention of the participants to related sensory terms which then are perceived differently. This is in line with earlier findings that health claims on the front of the package leads to the

generation of more attribute-specific thoughts about the product by consumers (Wansink, Sonka, & Hasler, 2004).

This study has several limitations. First of all, one should note that the used sample is not representative for the Belgian population. However, the use of a convenience sample recruited at the university has been applied in several studies and often provides interesting insights. Given the reported socio-demographic characteristics of the sample and reported dietary intakes, one should consider that this study mainly involved consumers of a higher SES class. A future study could aim to work with a greater sample size in order to obtain more power for the statistical tests and make also additional analyses based upon segmentations possible. Further, this study did not control for additional measurements like the awareness or personal attitudes when performing the statistical analyses. The tests took place in a lab which could bias the results as it does not mimics the reality but it has the major advantage that the experiment could take place in a better controlled environment. It has been previously reported that the context could influence the sensory (Edwards, Meiselman, Edwards, & Lesher, 2003; Köster, 2003) and emotional profiling (Desmet & Schifferstein, 2008; Porcherot, Petit, Giboreau, Gaudreau, & Cayeux, 2015) of food products. It could be interesting for future research to actually conduct tests in a more realistic situation e.g. a shopping situation in a grocery store or the use of a product during a home use test. This study used three health-related labels and one product. Further research is needed with other health-related labels and also other products to examine if they underpin the findings of this study. Dietary intakes were assessed using validated scales in this study. Although these scales have been validated, one should also consider to obtain dietary data with other methods such as food frequency questionnaires or food diaries in order to have a more in depth view on participants' dietary intake. Also, this study has opted to examine the influence of the label on the flavour perception by letting consumers evaluate the same product for each label. However, more research needs to be performed with products containing health-related labels which are actually different in flavour and determine the critical composition in order to have a good balance between flavour and overall acceptance.

The present study holds practical implications for the role of front-of-package labelling. These labels could influence the sensory expectations and perception of related sensory attributes like fat content and salt content. Further, these labels could impact the emotional conceptualisation of a food product. However, these effects are label-specific and the use of a reduced salt label did not lower the overall liking of cheese. Therefore, specific health-related labels might be used as a marketing tool in order to target specific health-oriented consumers and even yield potential for priming healthy food products.

4.5. References

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Chapter 5

Impact of content information on consumers' food experience of insect-, plant-, and meat-based burgers

This chapter is based on:
Schouteten, J.J., De Steur, H., De Pelsmaeker, S., Lagast, S., Juvenal, J., De Bourdeaudhuij, I., Verbeke, W., & Gellynck, X. (2016). Emotional and sensory profiling of insect-, plant- and meat-based burgers under blind, expected and informed conditions. *Food Quality and Preference*, 52, 27-31.

Abstract
The use of edible insects as a potential component of food products is gathering interest among scientists, policy makers and the food industry. Although recent research suggests that a growing number of Western consumers might be willing to consume food products containing edible insects or insect-based protein, little is known about the influence of ingredient information on product evaluation. The aim of this study was to examine (i) the overall liking, perceived quality and nutritiousness, and (ii) the emotional and sensory profiling of three commercially available burgers (insect-based, plant-based and meat-based), under blind, expected and informed conditions. In total, 97 young adults took part in this experiment, divided into two sessions to assess the effect of blind tasting. The findings of the study revealed that although the overall liking for the insect burger was comparable to the liking for the plant-based burger, further product development is needed to improve its sensory quality. Complete assimilation occurred for the insect-based burger, which shows that information influenced overall liking. Through examining interconnections between emotional conceptualisations, sensory attributes and liking, this study provides insights for product development and marketing purposes in order to optimize consumers' food product experience.

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5.1. Introduction

There is a growing interest in edible insects as a feed and food source across the world, mainly for their potential contribution towards ensuring global feed and food security for future decades (FAO, 2013). Several advantages of using insects in feed and food have been reported by the FAO. These include feed conversion efficiency, greenhouse gas and ammonia emissions, water use, and animal welfare. Besides the positive effects on the environment, edible insects are also considered a valuable food product with an adequate nutritional composition. Insects possess an acceptable energy and protein content, desirable amino acid and fatty acid profiles and a high content of numerous micronutrients, such as the minerals copper, iron, magnesium, manganese, phosphorous, selenium, and zinc and the vitamins biotin, pantothenic acid, riboflavin and, in some cases, also folic acid (Rumpold & Schluter, 2013).

Although it is estimated that around 2 billion people regularly consume edible insects, an issue which has often been reported is the rather limited consumer acceptance in Western countries (van Huis, 2013). Studies have identified several reasons for consumers' aversion towards food products containing edible insects, such as health and safety concerns (e.g. unsafe and linked with diseases), negative sensory perceptions (e.g. flavour, appearance, texture), entrenched attitudes (e.g. about sustainability), and cultural influence (e.g. edible insects might be classified as pest insects) (Lensvelt & Steenbekkers, 2014; Tan *et al.*, 2015; van Huis, 2013). Several food products containing edible insects have recently been launched in Europe. However, little is currently known about how consumers evaluate and experience such products.

To address this gap, it is necessary to explore the sensory experience beyond blind evaluation and also to include expected and informed evaluations of food products (Meiselman, 2013). It is well known that extrinsic factors, such as content information relating to nutritional composition, brands, or packaging could influence sensory evaluation when a discrepancy occurs between the expected and actual food experience (Piqueras-Fiszman & Spence, 2015). Four main psychological theories (Cardello, 1994; Cardello, 2007) could explain the different outcomes of the so-called disconfirmation effect: (1) assimilation theory depicts that product evaluation ratings shift towards prior expectations; (2) contrast theory applies when one magnifies the discrepancy, which leads to ratings shifting in the opposite direction instead; (3) generalized negativity theory applies when product ratings are always lower, as participants evaluate the product negatively due to it not meeting their prior expectations; (4) assimilation/contrast effect theory is involved when an assimilation effect is observed if there is only a small disconfirmation, while the contrast effect is detected if the discrepancy is too large (Piqueras-Fiszman & Spence, 2015).

Next to hedonic measurements, a growing number of studies also include the measurement of emotional conceptualisations of food products by consumers (Köster & Mojet, 2015). Such measurements provide additional information to discriminate between food products, even when overall acceptance is similar (Jiang, King, & Prinyawiwatkul, 2014; Köster & Mojet, 2015)

and improve food choice prediction (Dalenberg *et al.*, 2014). Furthermore, the assessment of sensory attributes by consumers could also provide additional information about how consumers perceive food products (Meiselman, 2013; Moussaoui & Varela, 2010).

The main objective of this study is to investigate and compare the acceptance of a food product containing edible insects as an alternative to meat- and plant-based products, by young adults. To obtain a broader perspective of consumers' food product experience, emotional and sensory profiling have been included and products have been evaluated under blind, expected (based on provided content information) and informed conditions.

5.2. Materials and methods

5.2.1. Experimental design

Participants were asked to evaluate three burgers and express their overall liking, perceived quality, perceived nutritiousness and EmoSensory® profile (Schouteten *et al.*, 2015). This recently introduced method uses a wheel format to obtain both emotional and sensory profiles of products by consumers. Here, consumers applied the wheel under three different conditions:

- Blind condition (tasting): consumers were asked to evaluate the unbranded products in order to study the effect of the sensory attributes.
- Expected condition (no tasting): consumers were presented with the main composition of the burgers in order to study the effect of composition information. The insect-, plant- and meat-based burgers were presented as 'burger prepared with insects', 'vegetarian burger', and 'burger prepared with meat', respectively.
- Informed condition (tasting): consumers were asked to evaluate the products when they also had information about the main composition ingredient, in order to study the combined effect of the sensory attributes and the composition information.

The expected and informed conditions were assessed during the same (i.e. the second) session, which is a similar design to the one used by Spinelli, Masi, Zoboli, Prescott, and Monteleone (2015).

5.2.2. Participants

A total of 97 consumers took part in this experiment. The study participants were young adult volunteers who were recruited close to the university campus. Fifty-three participants (mean age 27 years old, 64% male) evaluated the products under each of the three conditions during two sessions (first consumer sample). Six participants were unwilling to taste the insect-based burgers during the informed session and their data have therefore been excluded from the data analysis. In addition, 38 consumers only participated in the second session, and thus were only exposed to the expected and informed conditions (second consumer sample). Their data were also used to examine whether prior tasting had an influence on the overall liking under the informed condition.

5.2.3. Samples

All study samples were burgers, the purpose being to have a familiar food product from one specific product category. Insects were not visible in the insect-based burger. Three burgers were selected for this study and all were commercially available. The plant-based burger ('Garden Gourmet' brand) contained 19% vegetable protein (soy and wheat) while the meat burger ('Beckers' brand) consisted of 80% meat (71% chicken and 9% pork). The insect-based burger ('Bens Bugs' brand) contained 31% mealworms. The number of products was limited to three burgers based on previous suggestions for emotional research by King, Meiselman, and Carr (2013). All burgers were bought in frozen condition to ensure a similar sensory quality

during the two different sessions. Burgers were prepared according to the instructions provided on the package and each participant was served a sample sufficient for two to three bites. Samples were monadically served in transparent containers following a randomized complete block design. Products were coded using a random 3-digit number.

5.2.4. Evaluation procedure

Consumer tests were carried out at sensory facilities at Ghent University using EyeQuestion v.3.14.0 (Logic8 BV). Participants for the three conditions (first consumer sample) attended two sessions, with two to three weeks between the sessions depending on the participant's availability. Consumer tests for the second consumer sample took place in the same time period as the second session for the first consumer sample.

During the first session, participants tasted each product blind and then rated overall liking (9-point scale), quality (7-point scale), nutritiousness (7-point scale) and assessed the emotional and sensory profile using the EmoSensory® Wheel questionnaire format (using a 5-point RATA scale). Emotional and sensory terms were determined during blind, expected and informed conditions using the two-step procedure described by Schouteten *et al.* (2015). In total, 14 emotional and 12 sensory terms were included (Table 5.1).

Table 5.1 Overview of emotional and sensory terms used in the EmoSensory® Wheel

Emotional terms	Sensory terms
Pleasant surprise^{+}	Brown colour
Worried^{-}	Homogenous
Glad^{+}	Dry
Energetic^{+}	Granular
Happy^{+}	Aftertaste
Discontented^{-}	Nutty flavour
Dissatisfied^{-}	Off-flavour
Pleasant^{+}	Juicy
Disappointed^{-}	Meat aroma
Contented^{+}	Meat flavour
Fear^{-}	Soft
Merry^{+}	Salty
Disgust^{-}	
Distrust^{-}	

$^{+,-}$ means positive/ negative classified emotion

In the second session, participants first completed the expected condition in which they assessed expected overall liking, quality and perceived nutritiousness for the three burgers, e.g. 'how much do you expect to like a vegetarian burger'. The label 'burger prepared with insects' was accompanied by the statement 'Insects are a good source of high-value proteins, their production requires little space, their feed conversion is efficient, and therefore eating insects provides benefits in terms of sustainability. Also, edible insects have been approved for human consumption by the Federal Agency for the Safety of the Food Chain (FAVV) in 2014 in Belgium' as suggested by previous research (van Huis, 2013; Verbeke, 2015). Furthermore, participants were asked which emotional conceptualisations they associate with the labelled burgers. After

the expected condition, there was a short break foreseen before participants were asked to taste the labelled burgers and evaluate their overall liking, quality, perceived nutritiousness and EmoSensory® profiling.

5.2.5. Data analysis

Repeated measures ANOVA was performed to blind, expected and informed liking, perceived quality and perceived nutritiousness scores to determine whether products were evaluated as different from each other. Paired t-tests were used to examine how expectations on the information labels influenced the informed liking scores by investigating differences between expected and blind (E–B), informed and blind (I–B) and informed and expected (I–E) conditions following (Ng, Chaya, & Hort, 2013b). In addition, t-tests were performed on the informed liking scores for the products, between the participant groups who participated during the blind test (n=53) and those who did not (n=38).

Emotional and sensory data were treated as check-all-that-apply by only using the frequency of selection (Ares *et al.*, 2014). In other words, if a person indicated that a certain emotional / sensory term was applicable, then this term was coded as 1. If the emotional / sensory term was not selected, then it was coded as 0. A comparison of data for the terms associated with the products under a condition was performed using the Cochran's Q-test for each term. Pairwise comparison between the products for each term during a specific condition was performed using the McNemar-test. The same approach was used to compare the emotional associations with a product under the different conditions, while the McNemar-test was used to compare the use of the sensory terms for each product between the two evaluation conditions.

A synthetic view of consumers' evaluation of the samples was provided by using multiple factor analysis (MFA). MFA was conducted on the total frequency counts of the emotional and sensory terms separately under the evaluated conditions following Ng *et al.* (2013b). Further, MFA was performed in order to simultaneously evaluate consumers' emotional and sensory data under the informed condition while considering overall liking as a supplementary variable. MFA was conducted on the mean liking scores and total frequency counts of emotional and sensory terms for each product.

Statistical analyses were performed using IBM® SPSS® Statistics 22, except for the MFA which was achieved using XLSTAT Version 2015.6.01. A p-value of 0.05 was used as the threshold for significance with each statistical test.

5.3. Results

5.3.1. Overall liking, perceived quality and perceived nutritiousness across conditions

Significant differences were found in consumers' overall liking of the products under blind, expected and informed conditions ($p<0.01$) (Table 5.2). Although all products were commercially available on the Belgian market, only the burger prepared with meat emerged as a liked product (mean liking score above 6 = liked slightly). Both the plant- and insect-based burgers obtained low overall liking scores. Furthermore, previous tasting had no influence on the informed liking of a burger, as no significant differences were found between the participant groups.

Disconfirmation occurred for the meat- and insect-based burgers, as the blind liking differed significantly from the expected liking (Table 5.2). Tasting the burgers with information only had a significant effect on overall liking for the labelled insect-based burger, as expressed by the significant I-B score. The overall acceptance was significantly higher when consumers were informed that the burgers were prepared with insects. Furthermore, it is possible to determine whether a contrast effect ((I–B)/(E–B) < 0) or an assimilation effect ((I–B)/(E–B) > 0) occurred (Stolzenbach, Bredie, Christensen, & Byrne, 2013). An assimilation effect was identified for all three products. In particular, for the burger prepared with insects, the assimilation was complete as the informed and expected liking scores did not differ significantly.

Table 5.2 Blind (B), expected (E) and informed (I) mean (S.D) liking scores for products evaluated under blind, expected and informed conditions by consumers (on a 9-point scale), together with differences between mean ratings (n = 53)

Burger	B	E	I	E-B	I-B	I-E
Meat-based	6.45 (1.32)[a]	6.87 (1.06)[a]	6.68 (1.38)[a]	0.42*	0.23	0.19
Plant-based	4.72 (1.86)[b]	4.75 (1.60)[b]	4.87 (1.80)[b]	0.04	0.15	0.11
Insect-based	3.58 (1.75)[c]	4.43 (1.44)[b]	4.17 (1.61)[b]	0.85**	0.59*	0.26

I–B denotes informed minus blind liking scores; E–B denotes expected minus blind liking scores; I–E denotes informed minus expected liking scores

[a,b,c] Products with the same letter code, within a column, are not significantly different ($p \leq 0.05$) during the condition (blind / expected / informed)

The perceived quality and nutritiousness also differed significantly between the products and conditions (Table 5.3). While the perceived quality of the insect-based burger was rated significantly lower under the blind condition, as compared to the informed condition, the mean quality ratings for the other burgers were similar under the blind and informed conditions. Furthermore, the plant- and insect-based burgers were perceived as more nutritious compared to the meat-based burger during the informed condition.

Table 5.3 Blind (B), expected (E) and informed (I) mean (S.D.) perceived quality and perceived nutritiousness scores (7-point scale) of products evaluated under blind, expected and informed conditions by consumers (n = 53)

	Perceived quality			Perceived nutritiousness		
Burger	B	E	I	B	E	I
Meat-based	4.00 (1.27)^{a}	3.87(1.18)	4.02 (1.38)	3.30 (1.14)	3.55 (1.28)^{a}	3.43 (1.23)^{a}
Plant-based	3.60 (1.35)^{aA}	4.36 (1.29)^{B}	4.17 (1.22)^{B}	3.75 (1.33)	4.11 (1.52)^{b}	4.21 (1.10)^{b}
Insect-based	2.70 (1.37)^{bA}	4.43 (1.15)^{B}	3.70 (1.12)^{C}	3.75(1.37)^{A}	4.89 (1.14)^{bB}	4.57 (1.22)^{bB}

^{ABC} Condition with the same letter code, within a row, are not significantly different for either quality or nutritiousness perception ($p \leq 0.05$)

^{a,b,c} Products with the same letter code, within a column, are not significantly different ($p \leq 0.05$)

A row/column without any letters indicates that the perceived quality / nutritiousness was not significantly different between the samples

5.3.2. Emotional profiles across conditions

The total frequency count for the emotional conceptualisation terms varied from 0 to 31 (Table 5.4) while the maximum possible frequency count was 53. The average percentage of emotional terms used was in line with other studies (King *et al.*, 2013; Piqueras-Fiszman & Jaeger, 2014a). In general, consumers tended to use positive emotions more often for the meat-based burger compared to the plant-based and insect-based burgers. While previous research mostly found that consumers tend to associate food products with positive valence emotional terms instead of negative terms (Jiang *et al.*, 2014; Köster & Mojet, 2015; Meiselman, 2015), this was less so for the plant-based and insect-based burgers in this study. It is worth mentioning that the negative emotional terms were less frequently used when participants actually tasted the product. Furthermore, it is interesting that 'distrust' was used less when the participants were informed that insects were used to prepare the burger, compared to the blind evaluation.

Figure 5.1a shows the MFA representation of the emotional terms under the different conditions. The different conditions loaded each for at least 33% on the first dimension which accounted for about 74% of the variance. This first dimension was linked with the valence of the emotional terms as it was highly positively associated with positively valenced emotional terms as 'happy', 'merry' and 'contented' while it was negatively associated with negatively valenced emotions such as 'disappointed' and 'disgust'. This is in line with previous reported results (Gutjar *et al.*, 2015; Ng *et al.*, 2013b). The product configurations in the emotional space measured for the three conditions is set out in Figure 5.1b. For each product, three partial points are shown which are each representing one condition, and its compromise position in the middle. The location of the expected and informed representation of the meat-based product is very close to each other, whereas the informed representation of the insect-based burger is closer associated with the blind evaluation. Regarding the plant-based burger burger, the product representation of the expected condition is almost in the middle of the product representation under the blind and informed condition. High RV coefficients were found between on one hand the blind and informed condition (RV = 0.977) and on another hand the expected and informed condition (RV = 0.995).

Table 5.4 Frequency count for emotional terms across products and conditions (n=53)

	Blind			Expected			Informed		
	Meat-based	Plant-based	Insect-based	Meat-based	Plant-based	Insect-based	Meat-based	Plant-based	Insect-based
Contented^{+}	29^{a}	10^{bAB}	7^{b}	31^{a}	13^{bB}	13^{b}	30^{a}	23^{aA}	8^{b}
Energetic^{+}	3	0^{A}	4	11	11^{B}	11	8	3^{AB}	6
Glad^{+}	10	4	3^{A}	19	13	12^{B}	16^{a}	8^{ab}	2^{bA}
Happy^{+}	10^{aA}	0^{bA}	3^{ab}	23^{aB}	6^{bB}	6^{b}	17^{aAB}	5^{bAB}	8^{b}
Merry^{+}	6	1^{A}	2^{A}	26^{a}	13^{bB}	10^{bB}	14^{a}	6^{abAB}	2^{bA}
Pleasant surprise^{+}	9	10	6	6	13	13	6	13	12
Pleasant^{+}	11^{aA}	4^{ab}	3^{b}	27^{aB}	10^{b}	5^{b}	10^{aB}	10^{a}	3^{b}
Disappointed^{-}	3^{aAB}	18^{bAB}	20^{b}	1^{aB}	23^{bA}	9^{c}	8^{A}	15^{B}	15
Discontented^{-}	5^{a}	19^{b}	18^{bA}	1^{a}	13^{b}	6^{abB}	3^{a}	20^{b}	15^{bA}
Disgust^{-}	2^{a}	12^{b}	13^{b}	3^{a}	10^{a}	22^{b}	1^{a}	11^{b}	17^{b}
Dissatisfied^{-}	4	12^{A}	12	1^{a}	26^{bB}	11^{c}	2^{a}	11^{bAB}	10^{b}
Distrust^{-}	7^{a}	20^{bA}	18^{bA}	8^{a}	12^{aAB}	23^{bA}	3	8^{B}	5^{B}
Fear^{-}	2	5	1^{A}	6	7	15^{B}	1	2	6^{A}
Worried^{-}	5	7	5^{A}	8^{a}	4^{a}	18^{bB}	5	2	2^{B}

$^{+}$Positive, $^{-}$negative classified emotions

^{a,b,c} Frequency of emotional terms with the same letter are not significantly different between the products during a specific condition (blind / expected / informed)

^{A,B,C} Frequency of emotional terms with the same letter are not significantly different between the three conditions for a specific product (meat / plant / insect)

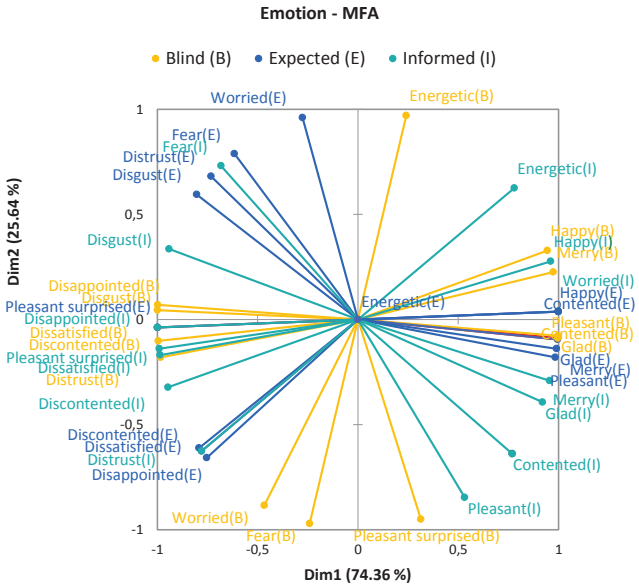

Figure 5.1a Representation of the emotional conceptualisations under the blind (B), expected (E) and informed (I) conditions.

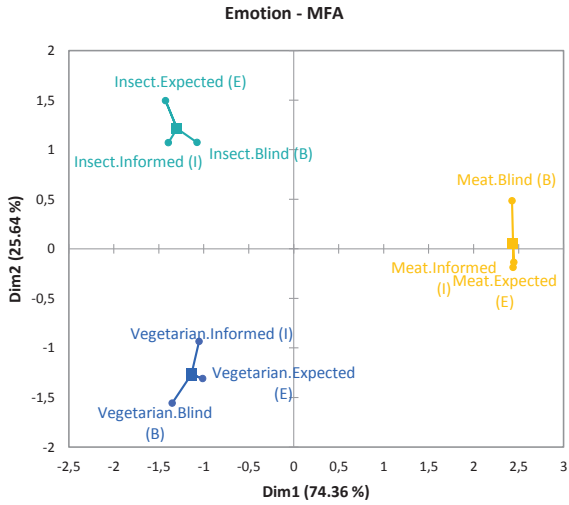

Figure 5.1b Superimposed representation of the first two dimensions of the MFA space showing the three products as mean points and their partial individuals representing the emotion configurations of the products evoked under the blind (B), expected (E) and informed (I) conditions

5.3.3. Sensory profiles across blind and informed conditions

The sensory profiles of the three burgers were different under both the blind and informed conditions (Table 5.5). The frequency of sensory term selection varied from 1 to 46. Significant differences were found between different sensory modalities: appearance (brown colour), aroma (meat aroma), flavour (meat flavour, nutty flavour, off-flavour and salty) and texture (juicy, granular and dry). The greatest differences between the burgers were found for the juiciness and dryness of the burgers, as the insect-based burger was experienced much more frequently as being dry and less juicy compared to the plant- and meat-based burgers. When comparing the blind and informed conditions, it is clear that the information had very little influence on the sensory profiling of a specific burger. Significant differences were only found for three attributes of the plant-based burger ('granular', 'meat flavour' and 'off-flavour') and only for one sensory attribute of the insect-based burger ('meat flavour').

The MFA representation of the sensory terms under the blind and informed conditions are presented in Figure 5.2a. Both conditions equally loaded on the first dimension which accounted for about 74.5% of the total variance. Product configuration of all the samples were very close to each other in the MFA-plot (Figure 5.3b). This is also reflected in the very high RV coefficient of 0.998 between both conditions.

Table 5.5 Frequency count of sensory terms across products under blind and informed conditions (n=53)

	Blind			Informed		
	Meat-based	Plant-based	Insect-based	Meat-based	Plant-based	Insect-based
Aftertaste	21	25	16	13	19	13
Brown colour	32^{a}	22^{b}	16^{b}	27^{a}	18^{ab}	14^{b}
Dry	2^{a}	16^{b}	47^{c}	2^{a}	9^{b}	46^{c}
Granular	3^{a}	19^{bA}	33^{c}	1^{a}	7^{bB}	34^{c}
Homogenous	12	10	13	13	7	8
Juicy	37^{a}	15^{b}	4^{c}	31^{a}	23^{a}	3^{b}
Meat aroma	22^{a}	10^{b}	7^{b}	26^{a}	8^{b}	4^{b}
Meat flavour	31^{a}	20^{bA}	13^{bA}	36^{a}	11^{bB}	3^{cB}
Nutty flavour	1^{a}	10^{b}	19^{c}	1^{a}	6^{a}	23^{b}
Off-flavour	9^{a}	32^{bA}	29^{b}	4^{a}	22^{bB}	27^{b}
Salty	12	8	13	17^{a}	7^{b}	9^{ab}
Soft	28^{a}	19^{a}	5^{b}	24^{a}	29^{a}	2^{b}

^{a,b,c} Frequency of sensory terms with the same letter are not significantly different between the products under a specific condition (blind / informed)

^{A,B} Frequency of sensory terms with the same letter are not significantly different between the two conditions for a specific product (meat / plant / insect)

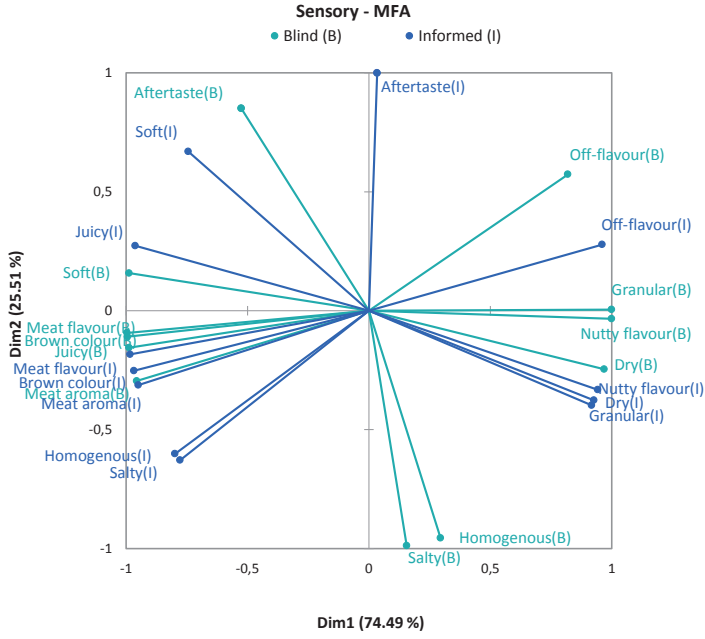

Figure 5.2a Representation of the sensory attributes under the blind (B) and informed (I) conditions

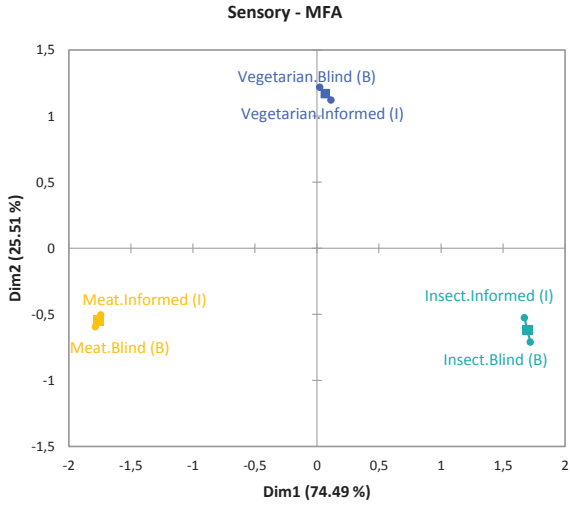

Figure 5.2b Superimposed representation of the first two dimensions of the MFA space showing the three products as mean points and their partial individuals representing the configurations of the sensory attributes evoked under the blind (B) and informed (I) conditions

5.3.4. Linking overall liking, emotional and sensory profiles under the informed condition

Figure 5.3a shows the variable correlation between the sensory characterization, emotional conceptualisations and overall liking under the informed condition. The three sets of data contributed almost evenly to the first dimension, while the second dimension was mainly explained by the sensory (60.1%) and emotional (37.2%) terms. On the first dimension, negatively valenced emotional conceptualisations were mainly on the left side, while positively valenced emotional conceptualisations were on the right side. The overall liking and sensory terms 'brown colour', 'meat aroma', 'meat flavour' and homogeneous determined this first dimension. The second dimension was mainly correlated with the emotional conceptualisations 'energetic' (8.4%), 'discontented' (7.0%), 'fear' (5.7%) and 'worried' (4.4%) and the sensory attributes 'aftertaste', 'soft' and nutty flavour.

The representation of the burger samples on the MFA dimensions is depicted in Figure 5.3b. The meat-based burger is strongly associated with overall liking, 'happy', 'salty', 'meat aroma', 'meat flavour', 'merry' and 'glad'. The insect-based and plant-based burgers were located on the left side of the spectrum. The insect-based burger was mainly correlated with the sensory terms 'granular', 'nutty flavour', 'dry' and the emotional conceptualisation 'fear'. The plant-based burger was closely linked to the emotional term 'discontented'.

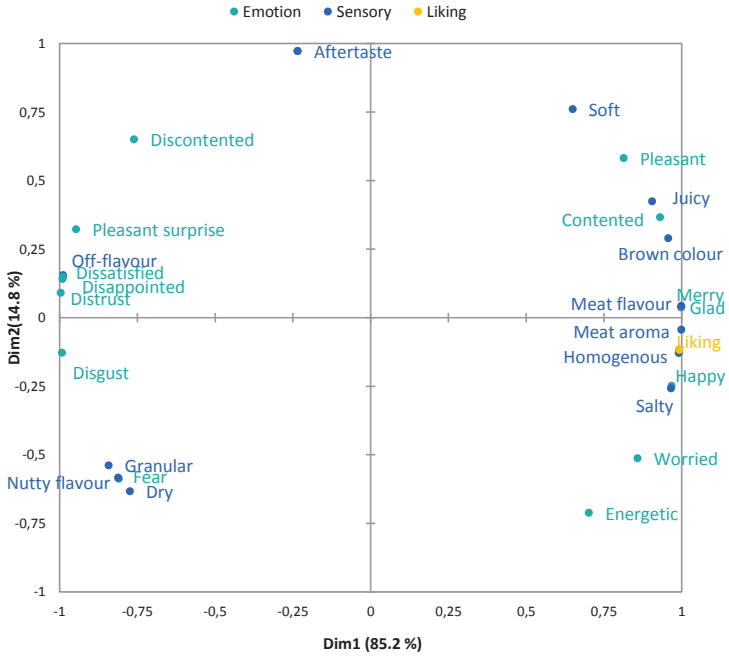

Figure 5.3a Representation of consumers' emotional conceptualisations, sensory attributes and mean overall liking (supplementary variable) scores in the first and second dimension of the MFA (n=91)

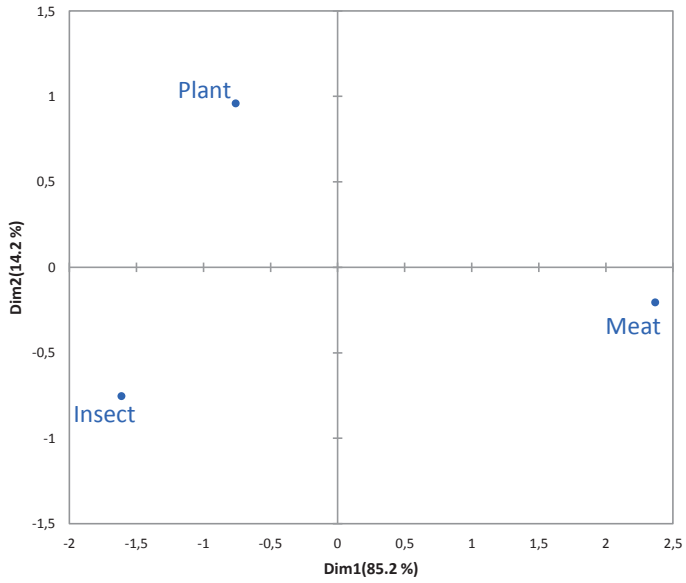

Figure 5.3b Representation of the burgers in the first and second dimension of the MFA (n=91)

5.4. Discussion

This study with young adults as target consumers showed that insect-based (and also plant-based) burgers generated rather low expectations and a low overall liking under the blind and informed conditions. However, liking for the insect-based burger was significantly higher under the informed condition, and an assimilation effect occurred for this burger. A potential explanation for this assimilation effect is that young adults might be more open to try food products prepared with insects (Verbeke, 2015) and / or are more willing to compromise on taste if informed about other (non-sensory) benefits associated with the product. During the informed evaluation, a statement about the benefits and food safety of the insect-based burger was presented, which might have (partially) contributed to the assimilation effect. Due to this statement, participants could have evaluated the burgers more in terms of the consequences of consuming an insect-based burger instead of assessing the overall liking for the insect-based burger itself (van Huis, 2013). The informed liking for the insect-based burger was lower than previous findings using mealworms in the same country (Caparros Megido *et al.*, 2014), although the mealworms were not served as a burger during the latter study. Given the low liking during the blind evaluation in this study, it seems that the low sensory quality of the product might be a major driver for the low overall acceptance of the insect-based burger. Because the sensory quality of a food product is known to be a major driver of food choice (Köster, 2009), it is of the utmost importance that producers of insect-based food products pay sufficient attention to the sensory properties during food product development. This is particularly so if they want to position their product as an alternative to meat, because resemblance to meat and its sensory quality is crucial for consumer acceptance (Hoek *et al.*, 2011). The perceived nutritiousness of the insect-based burger was significantly more highly evaluated than the meat-based burger during the informed condition, which yields potential for the future positioning and marketing of insect-based food products.

The emotional conceptualisations mostly differed between the meat-based burger on the one hand and the plant-based and insect-based burgers on the other hand. This was the case under each of the three conditions and is in line with previous research (Gutjar *et al.*, 2015; Ng *et al.*, 2013b; Spinelli *et al.*, 2015). Furthermore, the discriminative ability of some terms differed depending on the presentation condition, which corroborates the work of Ng *et al.* (2013b). The emotional terms 'glad', 'merry' and 'dissatisfied' were only discriminating when people consumed the products during the informed evaluation. As the presentation conditions can be considered as different stages of user-product interactions, different sensory modalities are of importance under each condition, and this might lead to the evocation of different emotional conceptualisations (Ng *et al.*, 2013b; Schifferstein, Fenko, Desmet, Labbe, & Martin, 2013). Different conditions were also found to be associated with different conceptualisations, even for the same product. This has also been reported previously (Ng *et al.*, 2013b; Spinelli *et al.*, 2015). For example 'fear' was associated more with the insect-based burger under the expected condition, as compared to the blind and informed conditions. While consumers tend to associate novel alternatives to traditional meat, such as insect-based foods or cultured meat

with fear (Caparros Megido *et al.*, 2014; Verbeke *et al.*, 2015), actual tasting of the product reduced the fear perception in this study. Indeed, when consumers evaluated the products under the informed condition, the emotional associations tended to be more similar to those evoked under the blind evaluation, but not to the expected emotions. This confirms recent findings (Gutjar *et al.*, 2015; Ng *et al.*, 2013b; Spinelli *et al.*, 2015) postulating that emotions are mainly sensory-driven as information alone has a limited impact on emotional profiling. Therefore, for insect-based burgers to become successful in the market, it is important that potential consumers are triggered to taste the product so that they associate positive emotions with the product (based on the satisfying sensory properties of the product) which might lead to the replacement of the negative expected emotions present prior to consumption. The sensory profiles for the burgers were very different. The applicability of 9 (blind) and 10 (informed) sensory attributes differed significantly across the three samples. This illustrates that each burger had its own sensory characteristics and is in line with consumer food product profiling research (Moussaoui & Varela, 2010). The information on the composition barely influenced sensory perception, i.e. the sensory profiling can be considered to be truly sensory driven. Previous studies have indicated that improving the appropriateness of consuming insect-based foods is crucial if such products are to become more widely consumed in Western countries (Tan, Fischer, van Trijp, & Stieger, 2016; Verkerk, Tramper, Van Trijp, & Martens, 2007). Although a good taste leads to an improvement in appropriateness, familiarity has an important role in introducing novel food products and should not be neglected (Tan *et al.*, 2016). Therefore, the clear difference from the familiar sensory profile of meat-based burgers might raise some concerns.

This study applied the recently introduced EmoSensory® Wheel which allows the collection of both emotional and sensory data from consumers. The MFA plot revealed which emotional conceptualisations are linked to sensory terms and overall liking under the informed condition. Insights obtained through this approach can be used for future product development and reveal marketing opportunities. Therefore, there needs to be a consonance between the product properties and the emotional conceptualisations in order to strengthen the marketing message and enhance the product experience by consumers (Ng *et al.*, 2013b; Spinelli *et al.*, 2015). Consumers were asked to assess their hedonic liking before conducting the emotional profiling for each burger. King *et al.* (2013) advised following this order to reduce the impact on the hedonic liking scores. However, it is unclear to what extent the hedonic liking could influence the emotional task and this requires further exploration.

This study opted to work with three commercially available burgers with different compositions besides the chosen main protein ingredient. Although this choice has the advantage that it better mimics the reality of real food choice and consumption, one needs to bear this limitation in mind when interpreting the relative comparisons between the burgers. However, even if the burgers were made with the same recipe (apart from the main protein ingredient), a variation in the ingredient in question might still have quite a large impact on consumers' burger

evaluations due to the different microstructural properties of the plant-, meat- and insect-based ingredients (Van Aken, 2007). Further research is needed to examine the effect of variation in only the main ingredient (plant / insect / meat) on the evaluation of food products, e.g. by using products with a similar composition apart from their main protein source.

This study developed and implemented a consumer-defined product-specific questionnaire, which is expected to be more discriminating compared to a standardized questionnaire (Ng et al., 2013a). Although product-specific questionnaires tend to be shorter and therefore have lower response fatigue (Ng, Chaya, & Hort, 2013a), one should take into account that the lexicon developed is context- and product-dependent. The findings show the added value of examining the expected and informed profiling of food products. Information such as composition could not only influence overall liking, quality and perceived nutritiousness, but also the emotional and sensory profiling of food products. As only written information was provided in this study, future research could examine whether a similar effect occurs based on pictures of ingredients or the package itself.

This study focused on one specific region only, where entomophagy is still in its infancy and where insect-based products are not fully trusted yet. This is illustrated by the fact that around 10% of the participants were unwilling to consume the burger during an informed session, although they tasted the same burger under a blind condition. Clearly, the idea of consuming insect-based products is not accepted by some Western consumers. Cultural beliefs (Tan *et al.*, 2015) and the consumption situation (Tan *et al.*, 2016) might have influenced participants' perceived appropriateness of consuming the insect-based burgers. A larger, cross-country sample would allow further examination of how Western consumers perceive the consumption of food products containing insects. Furthermore, testing only took place in a laboratory environment. This needs to be taken into account when interpreting the results, as the context could influence the emotional (Piqueras-Fiszman & Jaeger, 2014b) and sensory profiles (Edwards, Meiselman, Edwards, & Lesher, 2003) of food products. Therefore, future research should examine how people evaluate this type of food product in other context situations such as a restaurant, food fair or supermarket. This is of particular importance, as consumers indicated that their willingness to try insect burgers is dependent on the consumption situation, which is also linked to cultural norms and attitudes (Tan *et al.*, 2016). The authors have opted to examine burgers in which the insects were not visible, as previous studies have shown that more participants are willing to consume insect foods if the product is familiar and has a low ingredient visibility (Caparros Megido *et al.*, 2014; Tan *et al.*, 2015). It may also be interesting to examine to what extent the visibility of insects during the evaluation would affect consumers' product evaluations and emotional conceptualisations.

Results from this study indicate that the primary focus should be to improve the sensory appraisal of the insect-based burger. Even when consumers are willing to try the insect burger, they might not be willing to eat it again if they do not like the taste. The composition will not only affect the overall liking, but will also influence the emotions evoked by the consumption

of the burger. While it is positive that fewer consumers associated fear with the insect-based burger during the informed condition compared to the expected condition, a less granular texture could possibly lower the number of consumers associating fear with an insect-based burger. More attention should also be given to raising public awareness about insect-based foods. The high number of negative expected emotional conceptualisations associated with the insect-based burger indicates that a lot of consumers have doubts about this product category, even when a statement regarding the benefits and food safety is provided. Research suggests that both unfamiliarity and strong cultural negativity could lead to consumers deeming the consumption of insect-based food products as inappropriate (Tan *et al.*, 2016), which might, in turn, yield such negative emotions. Future research is recommended to examine different insect-based products, different informational strategies and the influence of different presentation contexts in order to obtain a better understanding of the potential of insect-based products in Western countries.

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Chapter 6

Effects of brand information and context on yoghurt product experience

This chapter is based on:
Schouteten, J.J., De Steur, H., Sas, B., De Bourdeaudhuij, I. & Gellynck, X. The impact of the research setting on the emotional and sensory profiling under blind, expected and informed conditions. A study on premium and private label yogurt products. *Journal of Dairy Science. In Press.*

Abstract
Food products are mainly blind evaluated by participants during traditional sensory tests, while external factors such as brand are often considered as key drivers of food choice. Moreover sensory and emotional evaluation of food products mostly occurs in a controlled laboratory environment, it is often criticized as it may not reflect a realistic situation for consumers. This chapter aims to examine the role of brand information and context (central location test versus home-use-test) on the overall acceptance, emotional and sensory profiling of five strawberry flavoured yogurts. Private label and premium brands were compared under three conditions: blind, expected and informed (brand logo). A total of 99 adult subjects participated in three sessions over three consecutive weeks. Results showed that overall liking only differed for 2 yogurt samples between the two different contexts under the informed evaluation condition whereas no effect of context was found under the blind and expect conditions. While emotional profiles of the products differed depending on the context, this was less the case of the sensory profiles. Furthermore, brand information clearly affected the sensory perception of certain attributes but had less influence on overall liking and emotional profiling. The results indicate that both scientists and food companies should consider the impact of the chosen methodology on the ecological validity when conducting sensory research with consumers.

Acknowledgement and notice
B. Bollaert is acknowledged for his help in the data collection. B. Bollaert conducted a similar experiment with yoghurt drinks. As the data collection was still ongoing when this doctoral thesis has been submitted, this data has not been included in this chapter nor elsewhere in this doctoral thesis.

6.1. Introduction

Overall acceptance is widely used as a sensory measurement to gain insight in food choice and preference (Lawless & Heymann, 2010). But although this measurement has been widely applied by both scientists and industry, food industry is still confronted with high market failure rates despite sensory research before product launch (Ryynänen & Hakatie, 2014; van Kleef, van Trijp, & Luning, 2005). Therefore, additional measurements by consumers like emotional and sensory profiling is gaining interest as a way to better understand consumers' motivations for food choice (Jiang, King, & Prinyawiwatkul, 2014; Meiselman, 2013; Varela & Ares, 2012). Although it is reported that the inclusion of emotional measurements increase food choice prediction (Dalenberg *et al.*, 2014), questions remain about the ecological validity (Schmuckler, 2001) of sensory research when conducting emotional profiling using blind-labelled product samples at a sensory facility (Jaeger *et al.*, 2016).

When consumers perceive an object such as a food product or food brand, conceptual associations will be generated triggering an emotional response which may be positively or negatively rewarding (Thomson, 2015). Conceptualizations can be broadly classified into two categories based upon their connotations: emotional or functional (Thomson, Crocker, & Marketo, 2010). It is important to notice that there is a clear distinction between emotional conceptualizations and emotions as this has implications both on scientific level (research methodology) and industry level (product development and marketing). Although there is a lack of a clear scientific definition of emotion (Köster & Mojet, 2015; Lane & Nadel, 2002; Thomson & Crocker, 2013), there is a consensus that an emotion is something short-term experienced by a person while emotional conceptualizations have more permanence (Thomson & Crocker, 2015). Further, conceptualisations are also more related to the object instead of the individual while emotions are highly dependent on the mood of the individual (Thomson & Crocker, 2015).

In recent years, several methods have been developed and applied for conducting the emotional profiling tasks with food products ranging from explicit self-report instruments to implicit methods such as autonomic measures of emotion (e.g. skin conductance, hearth rate) and brain states (e.g. fMRI) (Köster & Mojet, 2015). But most studies in food science have opted to work with self-report instruments (Gutjar, Dalenberg*, et al.*, 2015) such as the EsSense Profile™ (King & Meiselman, 2010), PrEmo (Gutjar, de Graaf*, et al.*, 2015), best-worst scaling (Crocker & Thomson, 2014), bullseye (Thomson & Crocker, 2014), EmoSensory® Wheel (Schouteten *et al.*, 2015b), EmoSemio (Spinelli, Masi, Dinnella, Zoboli, & Monteleone, 2014) and temporal dominance of emotions (Jager *et al.*, 2014). During a self-report consumer test, participants are instructed to indicate which emotional terms they are experiencing or associating when consuming a food product. The emotional lexicon can be either from a standard list e.g. EsSense Profile (King & Meiselman, 2010) or a consumer-defined lexicon specific for the product category under study (Jiang *et al.*, 2014). One could stipulate that these

self-report methods are reflecting emotional conceptualizations rather than specific emotions (Köster & Mojet, 2015; Thomson & Crocker, 2015). The measurement of emotional conceptualizations has gained momentum as it provides additional information to discriminate between food products, even when overall acceptance is similar (King & Meiselman, 2010; Ng, Chaya, & Hort, 2013a), and as its inclusion helps to improve food choice prediction (Dalenberg *et al.*, 2014; Gutjar, Dalenberg*, et al.*, 2015).

Besides emotional profiling, there is a growing interest in letting consumers performing the sensory profiling of food products in order to obtain a better understanding on how they experience the different sensory properties of food products (Valentin, Chollet, Lelievre, & Abdi, 2012). Several new methodologies have been developed such as check-all-that-apply (CATA), rate-all-that-apply (RATA), Napping® and flash profiling (Ares, Bruzzone*, et al.*, 2014; Varela & Ares, 2012). These new methods make it possible to cost-efficiently retrieve feedback regarding how consumers perceive several sensory modalities like aroma, flavour, texture and aftertaste (Varela & Ares, 2012). Although these methods need to be seen as an additional way to provide feedback next to traditional profiling with trained experts, several studies have shown that these methods have been successfully applied for describing and quantifying product differences (Cruz *et al.*, 2013; Reinbach, Giacalone, Ribeiro, Bredie, & Frøst, 2014; Valentin *et al.*, 2012; Varela & Ares, 2012).

In the field of sensory research, two different contexts are widely used to obtain consumer data; (i) central location tests (CLT) and (ii) home-use-tests (HUT) (Lawless & Heymann, 2010). The majority of the tests carried out in scientific and industry take place as a CLT where consumers are evaluating products in isolated sensory booths in order to control against panellist bias and confounding non-product influences (Bangcuyo *et al.*, 2015). Research has found that, depending on the product category, the evaluation context could influence the overall acceptance of food products (Boutrolle, Delarue, Arranz, Rogeaux, & Köster, 2007; Edwards, Meiselman, Edwards, & Lesher, 2003; Mouta, de Sá, Menezes, & Melo, 2016). Also, an evoked context effect has been even reported when consumers evaluated which emotions they experience while imagining a specific consumption context at a CLT (Piqueras-Fiszman & Jaeger, 2014a, 2014b, 2014c). But the question remains to which extent a real difference in testing location influences the sensory and emotional profiling of consumers.

Next to the context, the ecological validity also includes the materials which are used (Schmuckler, 2001). Food choice is influenced by intrinsic (sensory properties), extrinsic (e.g. price, brand, packaging size) and credence quality cues (e.g. organic production, fair trade) (Oude Ophuis & Van Trijp, 1995). Although the sensory properties of a product are of utmost importance, it is also essential to examine the influence of extrinsic and credence quality cues on the sensory and emotional evaluation of food products (Jaeger *et al.*, 2016; Meiselman, 2013; Spinelli, Masi, Zoboli, Prescott, & Monteleone, 2015). This will not only help to better understand consumers' evaluation of food products, but it also mimics better a real situation compared to the traditional blind sensory evaluation. One of the most important extrinsic cues

for food producers is the brand as it is used to distinguish with competitors' products (Di Monaco, Cavella, Di Marzo, & Masi, 2004; Fernqvist & Ekelund, 2014). Although branding is not a factor that has received a lot of attention in the sensory and consumer science field (Spinelli *et al.*, 2015), several studies have found that brand information might influence overall acceptance (Cavanagh & Forestell, 2013; Gutjar, Dalenberg*, et al.*, 2015; Paasovaara, Luomala, Pohjanheimo, & Sandell, 2012; Spinelli *et al.*, 2015) and purchase intent (Torres-Moreno, Tarrega, Torrescasana, & Blanch, 2012). But little is known on the effect of brand labels on the emotional and sensory profiling of food products as previous studies opted to work with whole packages (Gutjar, Dalenberg*, et al.*, 2015; Ng, Chaya, & Hort, 2013b; Spinelli *et al.*, 2015).

The objective of this study was twofold: (1) examination of the influence of (i) brand information and (ii) context (CLT vs. HUT) on the overall acceptance, sensory and emotional profiling. Strawberry flavoured yogurt products, both private and premium brands, were selected as the design stimuli. While emotional profiling is gaining momentum, it is still mainly applied using unhealthy snack products, which calls for research on products that are expected to evoke less emotions, such as dairy products (Jiang *et al.*, 2014; Sosa, Cardinal, Contarini, & Hough, 2015). Because increased yogurt consumption and production are attributed to the perceived health benefits of yogurt and its consumer appeal (Desai, Shepard, & Drake, 2013), yogurt has been selected as the product of interest for this study.

6.2. Materials and methods

6.2.1. Participants

A total of 99 adult subjects (45 males and 54 females with the mean age of 29 years) participated in three sessions. Slightly more than half of the respondents (54.5%) were living on the countryside. Only product users were eligible, in line with previous research showing that emotional profiles of non-users and users differed too much (King & Meiselman, 2010). Further exclusion criteria were based upon food allergies (milk and soy products) and intolerances (lactose-intolerant). Participants did not receive a monetary compensation for their participation and were not informed about the objective of the study.

6.2.2. Samples

All yogurt products were commercially available at the time of the study and bought in the local supermarkets. Private label brands of the three major retailers in Belgium (covering in total more than 65% of the grocery sales) as well as two premium brands were included in this study. The number of samples was limited to five in order to reduce sensory satiation of the participants (Gutjar, de Graaf*, et al.*, 2015). Further, only a small amount of the product samples was provided (three tablespoons) (Ares, Bruzzone*, et al.*, 2014; Gutjar, de Graaf*, et al.*, 2015). Products were strawberry flavoured yogurts and information about the products is listed in Table 6.1.

Table 6.1 Product information about the five test products used in this test with the product code, the product brand and the product classification

Product classification	Product brand	Product code
Premium	Pur Natur	P1
Premium	Danone	P2
Private label	365	PL1
Private label	Everyday	PL2
Private label	Carrefour	PL3

6.2.3. Emotional and sensory term selection

Emotional terms were determined by using a two-step procedure as suggested by prior research on developing a consumer-defined emotional lexicon (Ng *et al.*, 2013a). A consumer defined-lexicon has the advantage that it is more specific which leads to more discriminating terms compared to the standardized emotional list (Jaeger, Cardello, & Schutz, 2013; Kenney & Adhikari, 2016; Ng *et al.*, 2013a). Another benefit of consumer-defined lexicons is the exclusion of irrelevant terms, leading to a shorter response time, less consumer boredom and fatigue (Chaya *et al.*, 2015; Jaeger, Cardello*, et al.*, 2013). Further, most standardized lists such as the widely applied EsSense profile™ (King & Meiselman, 2010) often focus on either positively or negatively valenced terms which might result in capturing a less overall view of the product performance (Köster & Mojet, 2015; Spinelli *et al.*, 2015). During the first step, a

group of 20 consumers evaluated yogurt samples during three conditions: blind, expected and informed. Consumers were asked to point out emotional terms that are applicable when tasting the sample (blind/informed condition) and seeing the brand logo (expected condition) using the check-all-that-apply (CATA) method. The emotional terms during this first step were based upon prior research (Desmet & Schifferstein, 2008; King & Meiselman, 2010; Laros & Steenkamp, 2005) but consumers also had the possibility to add their own terms. Second, the researchers finalized the list using two criteria (i) number of consumers selecting the emotional terms (≥10% for negative terms and ≥ 15% for positive terms) and (ii) ability of the emotional terms to discriminate between the different samples (De Pelsmaeker, Schouteten, & Gellynck, 2013; Ferrarini *et al.*, 2010; Jiang *et al.*, 2014; Manzocco, Rumignani, & Lagazio, 2013; Ng *et al.*, 2013a; Thomson *et al.*, 2010). The final selection contained 18 emotional conceptualisation terms, of which 8 positively valenced (contented, friendly, good, happy, interested, pleasant, pleasant surprised, satisfied), 8 negatively valenced (bored, disappointed, discontented, disgust, dissatisfied, frustrated, stressed) and 2 neutral terms (calm, steady). This classification was based upon previous scholarly papers (King & Meiselman, 2010; Laros & Steenkamp, 2005) and terms that were opposites to those found in the literature (e.g. contented = positively valenced and therefore discontented = negatively valenced) were also classified this way (Ng *et al.*, 2013b).

Sensory terms were selected using a similar approach. Consumers (n = 20) checked the applicable sensory terms while evaluating yogurt samples during an blind, expected and informed condition. This master list was based upon pilot work and previous research (Ares, Bruzzone*, et al.*, 2014; Castura, Antúnez, Giménez, & Ares, 2016; Cruz *et al.*, 2013; Desai, Shepard, & Drake). In addition, consumers had the possibility to add sensory terms. Researchers made a final selection based upon the frequency of selection (≥ 15%) and the ability to discriminate between different yogurt samples. The final list contained terms covering multiple sensory modalities (appearance, aroma, flavour, texture and aftertaste) in line with previous research (Ares, Antúnez*, et al.*, 2014; Jaeger *et al.*, 2015; Schouteten *et al.*, 2015a). The following sensory terms were used to characterise the yogurt samples: aftertaste, creamy, dark colour, firm, fruity aroma, fruity flavour, homogeneous, liquid, milky flavour, off-flavour, smooth, sour, sweet and thick.

6.2.4. Evaluation procedure

The experiment was carried out with separate groups of consumers (one for CLT and one for HUT). Subjects were recruited upon the database with volunteers and on the campus of the faculty. All participants took part in three test sessions with an interval of one week in between each session. An schematic overview of the three sessions is provided in Figure 6.1. Participants only consumed the samples during the first and third session.

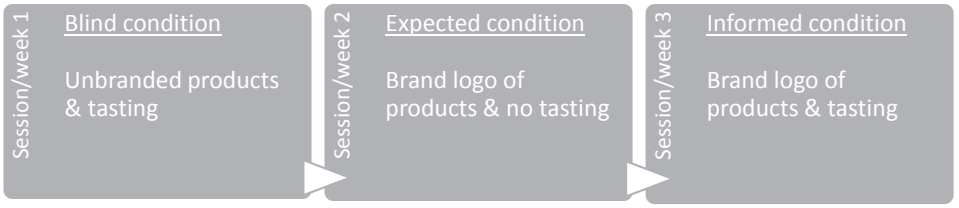

Figure 6.1 Schematic overview of the experimental design of the study

Consumer tests of the CLT tests took place in the sensory facilities of Ghent University using EyeQuestion 3.15.10 (Logic8 BV). Products were served in plastic transparent cups at a temperature of 6°C. Participants were instructed to eat a non-salty cracker and drink some water between the evaluation of the different samples in order to rinse their mouth. The presentation order of the samples was randomized between the subjects.

HUT took place in the same weeks of the CLT tests and computerised questionnaires (EyeQuestion 3.15.10) were used. A researcher visited the participants at home twice. The first time, the researcher provided the necessary materials for conducting the tests. The consumers did not use the product over a period of time, in order to make the test similar to the laboratory test (Hersleth, Ueland, Allain, & Næs, 2005). Consumers were instructed to evaluate the product when they wanted and together with family and / or friends but they were instructed to personally consume a minimal amount as was also clearly mentioned on the computerised questionnaire (Boutrolle *et al.*, 2007). Exactly one week later, participants of the HUT received electronically a link to complete the questionnaire of the second session. Lastly, a researcher payed a second visit to the participants in order to deliver the materials for the second session. The procedure for the sample evaluation was the same as for participants of the CLT test e.g. randomized sample presentation order and palate cleansing.

During the first session (tasting), consumers first answered general questions about their yogurt consumption, shopping behaviour and private label brands (not included in this study). Participants tasted each product, and then first rated overall liking using a 9-point scale. They were instructed to take a second spoon of the sample before completing the emotional and sensory profile task, which was based on the validated EmoSensory® Wheel format (Schouteten *et al.*, 2015b). Consumers were instructed to 'tick on each word that applies to describe yoghurt sample XXX and rate its intensity' for the sensory profiling task and to 'rate the intensity of the words which describe how you feel right now' for the emotional profiling task. These are the same instructions as the validated EmoSensory® Wheel (Schouteten *et al.*, 2015b) and similar to those applied in other consumer studies for the emotional (King & Meiselman, 2010) and sensory profiling (Jaeger, Chheang*, et al.*, 2013) of food products. The RATA approach (Ares, Bruzzone*, et al.*, 2014) was applied for the profiling task using a 5-point scale with end-point anchors 1 = 'slightly' to 5 = 'extremely'. Emotion and sensory terms were listed alphabetically to ease consumer's response process and as previous research concluded

that alphabetical order is not likely to bias the profiling results compared to a randomized order (Ares *et al.*, 2013; King, Meiselman, & Carr, 2013). Lastly, some socio-demographic questions were gathered (gender, age, place of living).

One week later, respondents participated in the second session (expected condition). They were presented with the brand logos of the selected samples in a randomized order. Participants were first asked to express their expected overall liking of a strawberry flavoured yogurt from the projected brand. Next, they assessed which emotions they associate with a that brand logo and to which extent they expect the presence of the sensory properties for yogurt of the projected brand.

The third session (tasting + informed) had the same structure as the second session but each consumer actually tasted the yogurt products during this informed condition. Participants were presented with the brand logos, in a randomized order, accompanied with the yogurt sample. They first assessed their overall liking and then conducted the EmoSensory® profiling task of each product sample.

6.2.5. Data analysis

ANOVA (factors: samples and location) was performed separately on the blind, expected and informed liking scores to determine to which extent liking scores differed between the locations for each condition (Boutrolle, Arranz, Rogeaux, & Delarue, 2005).

The procedure for data analysis of sensory and emotional terms was similar. Two approaches were used to analyse RATA data: (i) frequency of selection only or (ii) weighted frequency of selection (i.e. by assigning the points of the scale to numbers in increasing order corresponding the perceived intensity)(RATA scoring) (Ares, Bruzzone*, et al.*, 2014). This makes it possible to calculate the scores for each term of sample by summing up the scores provided by consumers who selected that term. Also, a recent study conducted by Meyners, Jaeger, and Ares (2016) suggests that a missing check can be interpreted as a 0, interpreting the obtained RATA data in this study as 6-point scales.

Further, the emotional and sensory profiles between the locations were compared on three levels: (i) term usage, (ii) sample differences and (iii) sample configurations for each condition (blind / expected / informed) separately (Ares, Bruzzone*, et al.*, 2014). Fisher's exact test was used to determine significant differences in the total number of terms used between the two experimental conditions (CLT and HUT) by participants to describe the whole sample set. While Cochran's Q test was carried out to determine significant differences of the frequency of term selection between conditions, Friedman's test was performed to identify significant differences for terms between samples taking the weighted frequency of selection into account. Lastly, correspondence analysis (CA) was conducted on both the frequency table containing the number of participants who used each term for describing each sample (RATA) and on the sum of scores given by all participants to each term for describing the intensity of the applicable term (RATA scoring). CA, using Hellinger's distances as recommended by Meyners, Castura,

and Carr (2013), was carried out for each experimental treatment comparing for each condition separately. The similarity between the sample and term configurations in the first two dimensions obtained from the CA was compared between the conditions using the RV coefficient for each condition separately.

For each location (CLT / HUT) and type of terms (emotional conceptualisation / sensory), significant differences in frequency of selection of each term between the yogurt samples were determined by applying Cochran's Q test for each condition. If significant differences were found, pairwise comparison between the products for each term during a specific condition was performed using the McNemar-test.

A two-way ANOVA (factors: subject and samples) and Fisher's LSD post hoc tests was independently applied to the blind, expected and informed liking scores to determine product differences. Student t-tests were carried out to detect differences between expected and blind (E – B), informed and blind (I – B) and informed and expected (I – E) liking scores following Ng *et al.* (2013b); Spinelli *et al.* (2015).

Repeated measures ANOVA with product presentation condition (3 levels: blind, expected and informed) and product (5 levels: product A-E) as within-subject factors was carried out to test for significant differences in term scores (dependent variable) for each product independently for each location (CLT / HUT) (Gutjar, Dalenberg*, et al.*, 2015). This test was performed for each of the 18 emotional and 14 sensory terms separately. Post-hoc pairwise comparisons with Bonferroni correction were carried out between the different conditions.

Multiple Factor Analysis (MFA) was conducted to examine the relationship between emotional and sensory data. MFA is a factor analysis method that compares multiple data sets and demonstrate patterns of attribute correlation (Lê, Pagès, & Husson, 2008; Morand & Pagès, 2006; Pagès, 2005). MFA was performed on the rata scoring data of the emotional and sensory terms for each product for each condition separately.

Statistical analyses were performed using IBM® SPSS® Statistics 22, except for the MFA which was achieved using XLSTAT Version 2015.6.01. A p-value of 0.05 was used as the threshold for significance with each statistical test.

6.3. Results

6.3.1. The effect of brand information

6.3.1.1. Overall liking

Significant differences were found in consumers' overall liking for the products under blind ($F(208, 4) = 5.100$, $p \leq 0.001$) and expected conditions ($F(208, 4) = 26.984$, $p \leq 0.001$) at the *CLT* (Table 6.2). During the blind condition, private-label product PL2 was the most liked while product P1 and PL1 the least. However, in the expected condition, product P2 (premium brand) was the most liked, while there were no significant differences in terms of overall liking between the samples in the informed condition ($F(208, 4) = 0.662$, $p = 0.619$) (Table 6.2). Results of the paired *t*-tests showed that the expected liking of the two premium was significantly higher compared to the blind assessment illustrating a negative disconfirmation effect. In contrast, overall liking of PL2 was significantly higher during the blind compared to the expected condition. This shows, in agreement with several other studies (Piqueras-Fiszman & Spence, 2015), that providing brand information can lead to higher expected liking scores. The informed scores were generally close to the blind liking scores, suggesting that the overall liking was mainly sensory-driven. However, for product P1, a complete assimilation effect occurred as informed liking was closer to the expected liking compared to the blind liking. This illustrates that for product P1, a premium brand, mentioning the brand logo has an significant effect on the overall liking.

During the *HUT*, significant differences in the overall liking were only present during the expected ($F(180, 4) = 17.186$ $p \leq 0.001$) and informed condition ($F(180, 4) = 4.091$, $p = 0.003$). The overall liking of premium brand PL2 was the highest during the expected condition, which was also the case in the CLT test. Participants of the HUT gave the highest informed overall liking scores to sample PL1 and P2. Interesting to note, no significant differences in terms of overall liking were found during the blind condition ($F(180, 4) = 0.898$, $p = 0.466$). Expected liking scores were significantly higher than the blind liking scores for the two premium brand samples when participants evaluated the samples at home. No significant differences were found between the informed and blind overall liking of any sample, indicating that the overall liking was little influenced by the brand information during the HUT. Further, informed liking scores were significantly lower compared to the expected scores for both premium brands. Although consumers have high expectations for both premium branded products, they are apparently not able to fulfil these expectations which led to an informed liking score comparable of those obtained during the blind evaluation of the yogurt products.

Table 6.2 Blind (B), expected (E) and informed (I) mean (S.D) liking scores of products evaluated under blind, expected (brand logo) and informed conditions by consumers (on a 9-point scale) at the CLT test (n = 53) and HUT (n = 46), together with differences between mean ratings for each sample
I–B denotes informed minus blind liking scores; E–B denotes expected minus blind liking scores; I–E denotes informed minus expected liking scores

Sample	B	E	I	E-B	I-B	I-E
CLT						
P1	5.1^{c}(1.9)	6.5^{b}(1.7)	5.9(1.5)	1.3***	0.8**	-0.5*
P2	5.8^{b}(1.6)	7.2^{a}(0.9)	6.0(1.4)	1.4***	0.2	-1.2***
PL1	5.5^{b,c}(1.7)	5.6^{c}(1.1)	5.7(1.8)	0.1	0.2	0.1
PL2	6.5^{a}(1.4)	5.8^{c}(1.3)	6.1(1.5)	-0.7**	-0.3	0.4
PL3	5.8^{b}(1.5)	5.5^{c}(1.0)	5.8(1.5)	-0.3	0.0	0.3
HUT						
P1	5.7(1.6)	6.5^{b}(1.4)	5.2^{c}(1.7)	0.7*	-0.5	-1.2***
P2	6.0(1.5)	7.0^{a}(0.9)	6.3^{a}(1.4)	1.0***	0.3	-0.7**
PL1	5.4(2.1)	5.7^{c}(1.2)	6.0a,^{b}(1.6)	0.2	0.6	0.4
PL2	5.9(1.7)	5.8^{c}(1.0)	5.5^{b,c}(1.8)	-0.1	-0.4	-0.3
PL3	5.8(1.8)	5.6^{c}(1.0)	5.3^{b,c}(1.5)	-0.2	-0.5	-0.03

^{a,b,c} Products with the same letter code, within a column, are not significantly different ($p \leq 0.05$) during the condition (blind / expected / informed)

*,**,*** depicts significant differences between the liking scores at respectively $p \leq 0.05$, $p \leq 0.01$ and $p \leq 0.001$

6.3.1.2. Emotional profiling across conditions

The *frequencies* of the discriminating emotional terms for each condition during the CLT are listed in Table 6.3. It is interesting to note that no emotional conceptualisation were discriminating between the five samples under all three conditions. Under the blind condition, only 3 (unpleasant surprised, frustrated and disgust) out of 18 emotional terms were discriminative and those three terms were all negatively valenced. More consumers used those negatively valenced terms for sample P1 compared to sample P2 and PL2. Half of the emotional conceptualisations terms were discriminative among the samples under the expected condition and those discriminating terms were mainly positively valenced. In general, yoghurts of the premium brands P1 and P2 were by more participants associated to the positive terms and less to the negatively valenced terms compared to the other three private label brands under the expected condition. Only two emotional terms, namely 'steady' and 'pleasant surprised' were discriminating between the products under the informed condition. More participants associated 'pleasant surprised' with PL2 and PL3 samples compared to the premium sample P2. Also, more respondents found yogurt P1 'steady' compared to the other premium brand P2 and also private label sample PL3.

Table 6.3 Frequency count of the discriminating emotional terms under the different conditions at the CLT test for each sample (n = 53)

Sample	P1	P2	PL1	PL2	PL3
Blind					
Disgust	12^{a}	2^{b}	$5^{a,b}$	1^{b}	3^{b}
Frustrated	7^{a}	1^{b}	1^{ab}	2^{ab}	$2^{a,b}$
Unpleasant surprised	$13^{a,b}$	$8^{a,c}$	15^{a}	2^{c}	$6^{b,c}$
Expected					
Bored	$2^{a,b}$	1^{b}	8^{a}	$3^{a,b}$	$4^{a,b}$
Dissatisfied	$2^{a,b}$	1^{a}	$6^{a,b}$	9^{b}	$7^{a,b}$
Friendly	17^{a}	$11^{a,b}$	$9^{a,b}$	7^{b}	8^{b}
Good	$21^{a,b}$	32^{c}	$19^{a,b}$	$26^{b,c}$	17^{a}
Happy	$13^{a,c}$	16^{a}	5^{b}	$6^{b,c}$	$7^{b,c}$
Interested	$5^{a,b}$	3^{b}	11^{a}	3^{b}	3^{b}
Pleasant	$18^{a,b}$	22^{a}	8^{c}	$10^{b,c}$	$9^{b,c}$
Satisfied	15^{a}	20^{a}	6^{b}	$12^{a,b}$	9^{b}
Steady	17^{a}	$10^{a,b}$	4^{b}	$10^{a,b}$	6^{b}
Informed					
Pleasant surprised	$10^{a,b}$	4^{b}	$12^{a,b}$	15^{a}	15^{a}
Steady	16^{a}	$6^{b,c}$	$11^{a,b}$	$12^{a,b}$	2^{c}

^{a,b,c} Frequency of emotional terms with the same letter code, within a row, are not significantly different ($p \leq 0.05$) during the specific condition (blind / expected / informed)

When checking for significant differences in the number of participants checking an emotional term between the samples under a certain condition at the HUT, the statistical test revealed that there were little differences present. Only a significant difference was found for the term 'pleasant' under the expected condition as more consumers used the term 'pleasant' for sample P2 (15 consumers) compared to sample PL1 and PL2 (both samples: 5 consumers).

Next to the frequency of use, the effect of brand information on the *intensity* of emotional conceptualisations for the same product was examined. The rating of the emotional terms differed between the conditions for the CLT mainly for product P1 with differences for 6 emotional terms (Table 6.4). When comparing the blind and informed conditions, it is clear that the brand information had rather limited influence on the emotional profiling of the samples during the CLT which is in line with previous research (Gutjar, et al. 2015a). A significant effect of the brand information on the emotional conceptualisations was only found for the terms 'pleasant' and 'pleasant surprised' of product PL3. Also for the HUT, little influence of brand information on the intensity of emotional ratings was found as only the intensity of the emotional conceptualisation 'pleasant' was significantly higher rated for PL3 when participants were informed about the brand. Further the significant differences in ratings between the conditions were all in the same direction for the different brands HUT: the intensity ratings of the emotional terms was lower during the expected condition compared to the blind and informed condition.

Table 6.4 Mean emotional ratings per product under the three conditions (B = blind, E = expected and I = informed) in the CLT (n = 53) and HUT (n = 46). Directions of significant main effects are indicated by arrows. Only the emotions with ratings that differed significantly between conditions are presented.

	CLT							HUT						
	B	**E-B**	**E**	**I-E**	**I**	**I-B**			**B**	**E-B**	**E**	**I-E**	**I**	**I-B**
P1								*P1*						
Disappointed	1.21[a]	↓	0.38[b]		0.66[a,b]			Disappointed	0.37[a,b]		0.07[b]	↑	0.98[a]	
Discontented	1.06[a]	↓	0.04[b]	↑	0.51[a]			Dissatisfied	0.43[a]	↓	0.00[b]	↑	0.74[a]	
Disgust	0.58[a]	↓	0.00[b]		0.26[a,b]			Pleasant surprised	0.35[a,b]		0.07[b]	↑	0.61[a]	
Friendly	0.19[b]	↑	1.09[a]		0.70[a,b]									
Steady	0.57[b]	↑	1.26[a]		0.93[a,b]									
Unpleasant surprised	0.81[a]	↓	0.06[b]	↑	0.53[a]									
P2								*P2*						
Disappointed	0.70[a]	↓	0.09[b]	↑	0.58[a]			Disappointed	0.33[a,b]		0.07[b]	↑	0.61[a]	
Good	0.85[b]	↑	2.08[a]	↓	0.87[b]									
Unpleasant surprised	0.40[a,b]		0.04[a]	↑	0.66[a]									
PL1								*PL1*						
Bored	0.09[a,b]		0.53[a]	↓	0.04[b]			Disappointed	1.02[a]	↓	0.22[b]		0.39[a,b]	
Disappointed	0.89[a]	↓	0.23[b]		0.68[a,b]			Disgust	0.52[a]	↓	0.00[b]		0.13[a,b]	
Disgust	0.23[a,b]		0.00[b]	↑	0.32[a]									
Unpleasant surprised	0.81[a]	↓	0.21[b]		0.43[a,b]									
PL2								*PL2*						
Interested	0.70[a]	↓	0.17[b]		0.64[a,b]			Dissatisfied	0.33[a,b]		0.07[b]	↑	0.63[a]	
Pleasant	1.26[a]	↓	0.53[b]	↑	1.15[a]			Disappointed	0.74[a]	↓	0.15[b]	↑	0.91[a]	
Pleasant surprised	0.87[a]	↓	0.32[b]	↑	1.00[a]			Pleasant surprised	0.87[a]	↓	0.11[b]		0.37[a,b]	
PL3								*PL3*						
Pleasant	0.92[a]		0.47[a,b]		0.34[b]	↓		Interested	0.80[a]	↓	0.15[b]		0.24[a,b]	
Pleasant surprised	0.43[b]		0.11[b]	↑	0.96[a]	↑		Pleasant	1.13[a]		0.41[a,b]		0.30[b]	↓
								Pleasant surprised	0.98[a]	↓	0.20[b]		0.52[a,b]	
								Satisfied	1.80[a]	↓	0.89[b]	↑	0.76[b]	

[a,b,c] Intensities of emotional terms with the same letter code, within a row, are not significantly different ($p \leq 0.05$) during for the product under a specific context (CLT/HUT)

6.3.1.3. Sensory profiling across conditions

Of the 14 sensory terms listed in the EmoSensory® Wheel, 11 terms presented significant differences between the samples under at least one condition for the CLT. Differences in *usage frequency* between the samples for the terms 'homogeneous', 'sour' and 'liquid' occurred during each condition, indicating that these are very discriminating between the samples. As at least the usage frequency of 6 sensory terms differed significantly under each condition, this shows that consumers perceived differences in the sensory characteristics of the yogurts under each condition at the CLT (Table 6.5).

Although the usage frequency of 13 out of 14 sensory terms were significant different when participants evaluated the samples at home, perceived differences in the sensory characteristics between the samples occurred mainly under the informed condition (9 terms). This suggests that brand information influences the sensory profiles of the yogurt products (Table 6.5).

Table 6.5 Frequency count of the discriminating sensory terms under the different conditions during the CLT test (n = 53) and HUT (n = 46)

	CLT						HUT				
	P1	**P2**	**PL1**	**PL2**	**PL3**		**P1**	**P2**	**PL1**	**PL2**	**PL3**
Blind						*Blind*					
Creamy	16^{b}	14^{b}	$24^{a,b}$	29^{a}	29^{a}	Aftertaste	$13^{a,b}$	17^{a}	$12^{a,b}$	6^{b}	17^{a}
Dark colour	10^{a}	2^{b}	$6^{a,b}$	1^{b}	2^{b}	Firm	9^{b}	$14^{a,b}$	11^{b}	21^{a}	20^{a}
Homogeneous	14^{bc}	27^{a}	12^{c}	21^{ab}	7^{c}	Homogeneous	8^{b}	25^{a}	14^{b}	13^{b}	13^{b}
Liquid	21^{a}	19^{a}	$12^{a,b}$	5^{b}	$10^{a,b}$	Liquid	19^{a}	$13^{a,b}$	$10^{a,b}$	6^{b}	$10^{a,b}$
Sour	29^{a}	13^{b}	$9^{b,c}$	4^{c}	13^{b}	Sweet	23^{b}	$32^{a,b}$	37^{a}	37^{a}	28^{b}
Thick	15^{bc}	10^{c}	9^{c}	26^{a}	13^{b}						
Expected						*Expected*					
Creamy	13^{b}	25^{a}	13^{b}	7^{b}	11^{b}	Creamy	$15^{a,b}$	20^{a}	7^{c}	$10^{b,c}$	$11^{a,b,c}$
Firm	19^{a}	17^{a}	7^{b}	8^{b}	$9^{a,b}$	Fruity aroma	11^{b}	19^{a}	$14^{a,b}$	$16^{a,b}$	22^{a}
Fruity flavour	34^{b}	45^{a}	27^{b}	32^{b}	29^{b}	Fruity flavour	23^{b}	33^{a}	20^{b}	22^{b}	21^{b}
Liquid	8^{b}	9^{b}	20^{a}	22^{a}	19^{a}	Thick	8^{a}	8^{a}	$3^{a,b}$	$4^{a,b}$	1^{b}
Off-flavour	11^{a}	1^{b}	12^{a}	11^{a}	11^{a}						
Sour	28^{a}	6^{b}	7^{b}	6^{b}	3^{b}						
Sweet	23^{b}	40^{a}	33^{a}	35^{a}	38^{a}						
Informed						*Informed*					
Homogeneous	18^{b}	29^{a}	11^{b}	16^{b}	10^{b}	Dark colour	$3^{a,b}$	$3^{a,b}$	$3^{a,b}$	0^{b}	8^{a}
Liquid	16^{a}	$12^{a,b}$	$8^{a,b}$	8^{b}	5^{b}	Firm	2^{a}	7^{a}	$9^{a,b}$	6^{a}	16^{b}
Off-flavour	9^{b}	$12^{b,c}$	19^{a}	7^{c}	$11^{b,c}$	Fruity aroma	10^{c}	$22^{a,b}$	$16^{a,b,c}$	24^{a}	$12^{b,c}$
Smooth	16^{b}	27^{a}	17^{b}	$21^{a,b}$	12^{b}	Homogeneous	11^{b}	20^{a}	9^{b}	4^{b}	5^{b}
Sour	26^{a}	16^{b}	11^{b}	12^{b}	12^{b}	Milky flavour	9^{b}	$12^{a,b}$	9^{b}	6^{b}	22^{a}
Sweet	24^{c}	$35^{a,b}$	39^{a}	39^{a}	$29^{b,c}$	Smooth	$19^{a,b}$	22^{a}	$11^{b,c}$	9^{c}	8^{c}
Thick	11^{b}	$17^{a,b}$	$17^{a,b}$	$17^{a,b}$	26^{a}	Sour	30^{a}	7^{b}	3^{b}	4^{b}	10^{b}
						Sweet	10^{b}	27^{a}	34^{a}	31^{a}	25^{a}
						Thick	6^{b}	9^{b}	8^{b}	$10^{a,b}$	20^{a}

^{a,b,c} Frequency of sensory terms with the same letter code, within a row, are not significantly different ($p \leq 0.05$) during the specific condition (blind / expected / informed)

In total, the *intensity* rating of 12 sensory terms differed between the three conditions for the same product at the CLT: aftertaste, creamy, dark colour, firm, fruity flavour, homogeneous, liquid, milky flavour, smooth, sour, sweet and tick. Significant differences between the conditions for the sensory terms were especially found for the premium sample P2 of which a main effect of condition was found for 8 terms. In contrast, there was little influence of condition on the sensory profiling of the other premium sample P1 (Table 6.6).

Exploring the intensity of sensory terms that differentiate between the three conditions for the same product for the HUT, statistical tests revealed significant main effects of the condition for 12 out of 14 sensory terms (aftertaste, creamy, firm, fruity aroma, homogeneous, liquid, milky flavour, off-flavour, smooth, sour, sweet and thick). The number of sensory terms of which the intensity differed between the conditions ranged from 5 (P1, P2 and PL1) to 7 terms (PL3) for the samples (Table 6.6). While brand information had little impact on the perceived intensity of the sensory attributes when participants evaluated the samples at the CLT, brand information influenced the sensory perception of at least one sensory attribute for four out of five samples (P1, P2, PL2 and PL3) when consumers were conducting the profiling task at home.

Table 6.6 Mean sensory intensity ratings per product under the three conditions (B = blind, E = expected and I = informed) at the CLT (n = 53) and HUT (n = 46). Directions of significant main effects are indicated by arrows. Only the sensory terms with ratings that differed significantly between conditions are presented.

	CLT							HUT						
	B	**E-B**	**E**	**I-E**	**I**	**I-B**		**B**	**E-B**	**E**	**I-E**	**I**	**I-B**	
P1								*P1*						
Liquid	0.98[a]	↓	0.36[b]		0.81[a,b]			Firm	0.69[a,b]		0.85[a]	↓	0.15[b]	
Sweet	1.68[a]	↓	1.00[b]		1.13[a,b]			Liquid	1.35[a]	↓	0.52[b]		0.76[a,b]	
								Off-flavour	0.72[a]	↓	0.11[b]		0.50[a,b]	
								Sour	0.65[b]		0.70[b]	↑	2.1[a]	↑
P2								*P2*						
Aftertaste	0.81[a]	↓	0.13[b]	↑	0.58[a]			Aftertaste	1.00[a]	↓	0.04[b]		0.37[a,b]	
Creamy	0.87[b]	↑	1.64[a]		1.40[a,b]			Homogeneous	2.33[a]	↓	0.54[b]	↑	1.67[a]	
Homogeneous	1.87[a,b]		1.21[b]	↑	2.25[a]			Off-flavour	1.07[a]	↓	0.00[b]		0.30[b]	↓
Fruity flavour	2.13[b]	↑	3.21[a]	↓	2.06[b]			Smooth	1.65[a]	↓	0.59[b]	↑	1.67[a]	
Liquid	1.23[a]	↓	0.45[b]		0.64[a,b]			Sour	0.63[a]	↓	0.11[b]		0.30[a,b]	
Milky flavour	0.64[a,b]		0.21[b]	↑	1.11[a]			Sweet	1.74[a]		0.93[a,b]		0.52[b]	↓
Smooth	1.58[a,b]		0.79[b]	↑	1.75[a]									
Sour	0.60[a]	↓	0.15[b]	↑	0.62[a]									
PL1								*PL1*						
Aftertaste	0.85[a]	↓	0.28[b]		0.74[a,b]			Creamy	1.67[a]	↓	0.39[b]	↑	1.61[a]	
Creamy	1.51[a]	↓	0.58[b]		1.28[a,b]			Smooth	1.37[a]	↓	0.43[b]		0.72[a,b]	
Fruity flavour	2.64[a]	↓	1.43[b]	↑	2.41[a]			Sweet	2.78[a]	↓	1.59[b]	↑	2.70[a]	
Liquid	0.83[a,b]		1.19[a]	↓	0.34[b]			Thick	0.96[a]	↓	0.17[b]		0.54[a,b]	
PL2								*PL2*						
Creamy	2.04[a]	↓	0.34[b]	↑	1.19[a]			Creamy	1.85[a]	↓	0.59[b]		1.26[a,b]	
Dark colour	0.06[b]		0.30[a,b]		0.57[a]	↑		Firm	1.65[a]	↓	0.52[b]		0.46[b]	↓
Firm	1.36[a]	↓	0.51[b]		0.92[a,b]			Homogeneous	1.02[a]		0.70[a,b]		0.27[b]	↓
Liquid	0.23[b]	↑	1.34[a]	↓	0.34[b]			Liquid	0.22[a]	↓	1.11[b]		0.54[a,b]	
Thick	1.55[a]	↓	0.30[b]	↑	0.96[a]			Sweet	2.91[a]	↓	1.30[b]	↑	2.33[a]	
								Thick	1.63[a]	↓	0.04[c]	↑	0.61[b]	↓
PL3								*PL3*						
Creamy	1.89[a]	↓	0.43[b]	↑	1.75[a]			Aftertaste	1.09[a]	↓	0.28[b]		0.67[a,b]	
Firm	1.04[a,b]		0.43[b]	↑	1.79[a]			Creamy	1.59[a]	↓	0.59[b]		1.11[a,b]	
Liquid	0.55[a,b]		1.19[a]	↓	0.26[b]			Firm	1.57[a]	↓	0.35[b]	↑	1.28[a]	
Sour	0.51[a]	↓	0.11[b]		0.51[a,b]			Fruity aroma	1.65[a]		1.46[a,b]		0.72[b]	↓
Thick	0.77[b]		0.53[b]	↑	1.66[a]	↑		Liquid	0.61[a,b]		0.89[a]	↓	0.13[b]	
								Milky flavour	0.80[a]		0.22[b]	↑	1.37[a]	
								Thick	1.20[a]	↓	0.07[b]	↑	1.41[a]	

[a,b,c] Intensities of sensory terms with the same letter code, within a row, are not significantly different ($p \leq 0.05$) during for the product under a specific context (CLT/HUT)

6.3.1.4. Linking emotional and sensory profiling

Figures 6.2, 6.3 and 6.4 (a,b) show the MFA plots according to the emotional and sensory profiling data under respectively the blind, expected and informed condition of the CLT. The use of MFA under the three conditions explained in between 70% and 80% of the total variance in the first two dimensions.

Figure 6.2a depicts the variable correlation circle obtained by MFA under blind condition. The first two dimensions accounted for 73.7% of the variance, with the first dimension explaining 52.2% of the total variance and the second dimension an additional 21.4%. When comparing the two tasting evaluations, namely the blind and informed condition, it is interesting to notice that it are mainly the same sensory terms which are highly associated with positively valenced emotional conceptualisations. Under the blind condition (Figure 6.2a), sensory terms 'thick', 'homogeneous', 'sweet', 'fruity flavour', 'creamy' and 'fruity aroma' are associated with these positive emotional terms. The sensory terms 'homogeneous', 'smooth', 'fruity flavour', 'fruity aroma', 'sweet' and 'creamy' are highly correlated with the positively valenced emotional terms under the informed condition (Figure 6.4a).

Figure 6.2b displays the representation of the yoghurt products in the MFA dimensions under the blind condition. The first and second dimensions sorted the samples according to their emotional and sensory profiling considering overall liking scores supplementary data. The product representation maps of the MFA indicates that the distance between the emotional and sensory terms is rather short under the blind condition. This is confirmed by the rather high RV coefficient between the emotional and sensory terms of 0.93. While PL2 is located at the positive side of both the first and second dimension, it is highly associated with sensory terms like 'firm', 'homogeneous' and 'thick' and emotional terms as 'pleasant surprised', 'contented' and 'satisfied'. On the other hand, the premium brand P1 is situated at the negative side of the first dimension and the positive side of the second dimension and is more associated with negatively valenced emotions as 'disgust', 'dissatisfied' and sensory characterisations 'milky flavour' and 'sour'. Further, it is interesting to note that the positions of the samples within a category (private label vs premium samples) are located in a different place in the MFA. This indicates that they could target other consumers. Also, it appears that the EmoSensory® profiling of premium sample P2 is very similar to the one of private label PL3 under the blind condition.

Under the expected condition (Figure 6.3b), it is possible to distinguish three groups of products. The first group is located on the negative side of the first dimension and consists of the three private label samples. A second group only contains only sample P1 while the last group is sample P2. Both sample P1 and P2 are located on the positive side of the first dimension but while sample P1 is located on the positive side of the second dimension, sample P2 is situated on the negative side of this second dimension. The RV coefficient between the emotional and sensory data was 0.83 under the expected condition.

Under the informed condition (Figure 6.4b), not only sample P2 and PL3 are close to each (just as in the blind condition), but also sample PL2 is closely located to both sample P1 and PL3. This indicates how brand information could influence the product characterisations. Those three brands are highly associated with positively valenced emotions 'happy', 'contented', 'interested' and 'pleasant' and sensory terms 'fruity flavour' and 'fruity aroma'. Also under the informed condition, a high RV coefficient was found between the emotional conceptualisation and sensory factors as the RV value was 0.84.

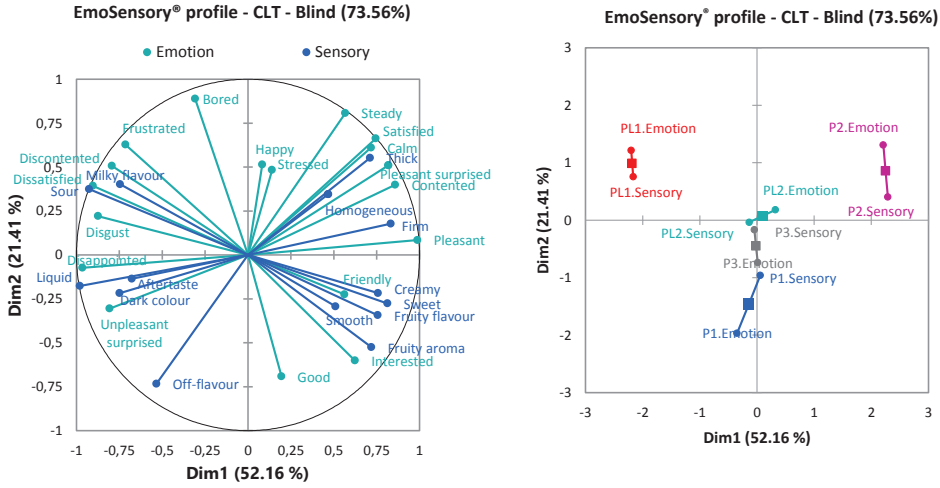

Figure 6.2 Representations of terms (a) and products (b) in the first two dimensions of MFA (CLT – blind condition)

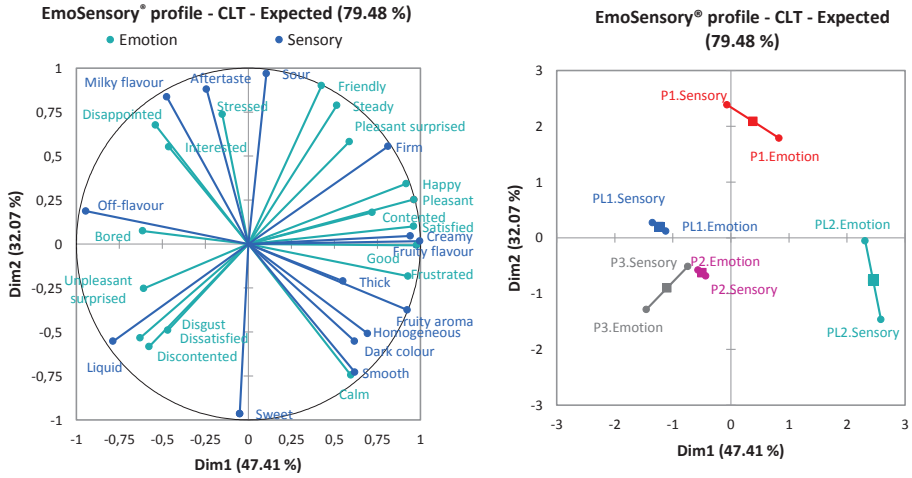

Figure 6.3 Representations of terms (a) and products (b) in the first two dimensions of MFA (CLT – expected condition)

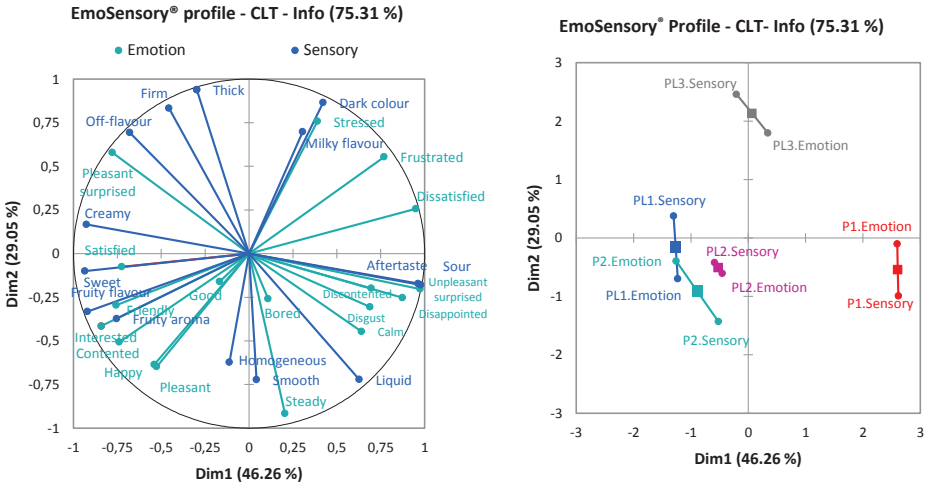

Figure 6.4 Representations of terms (a) and products (b) in the first two dimensions of MFA (CLT – informed condition)

Figures 6.5, 6.6 and 6.7(a,b) show the representation of the emotional and sensory in the MFA dimensions under respectively the blind, expected and informed condition of the tests performed as HUT. Although three emotional terms (pleasant surprises, satisfied and contented) loaded heavily on the first dimension, which accounted for 32.7% of the variance in the dataset, it were mainly sensory terms (in the present case firm, dark colour, creamy, thick, sour and liquid) which loaded heavily on this dimension in the blind condition (Figure 6.5a). On the other hand, emotional terms loaded heavily on the second dimension which accounted for 26.6% of the total variance. When not taking the emotional conceptualisations 'bored', 'stressed' and 'frustrated' into account, which all had rather low intensity scores and therefore might be less representative, the first dimension could be associated to the valence of the emotional conceptualisations. The sensory terms 'fruity aroma', 'firm', 'thick', 'dark colour', 'creamy', 'sweet', 'milky flavour' and 'fruity flavour' were all highly correlated with the positively valenced emotional conceptualisations. Under the expected condition (Figure 6.6a), the positively valenced emotional conceptualisations are highly correlated to the sensory terms 'firm', 'fruity flavour', 'thick', 'smooth' and 'creamy'. The sensory terms 'liquid' and 'sour', and to a lesser extent 'smooth' and 'homogeneous' were highly associated with the positively valenced emotional terms under the informed condition (Figure 6.7a). This indicates that when the tests were taking place at home, the correlations between the sensory and emotional terms tend to be more resembling between the blind and expected condition than to the blind and informed condition.

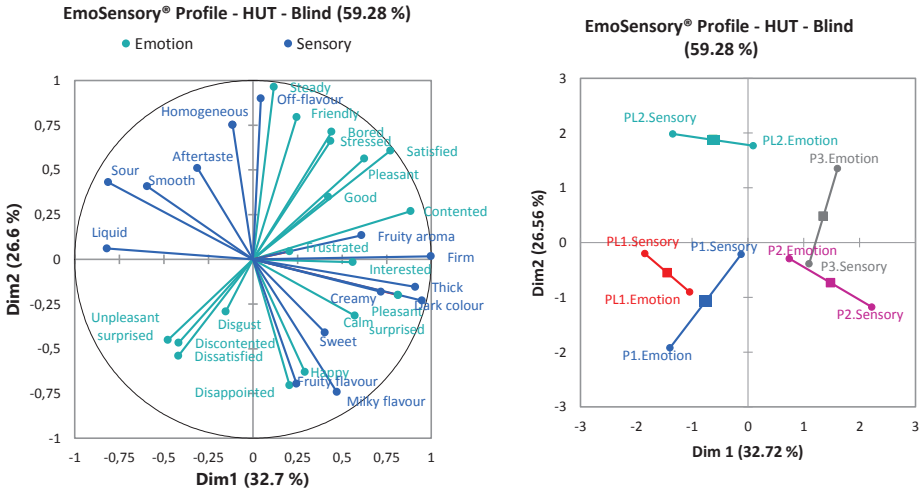

Figure 6.5 Representations of terms (a) and products (b) in the first two dimensions of MFA (HUT – blind condition)

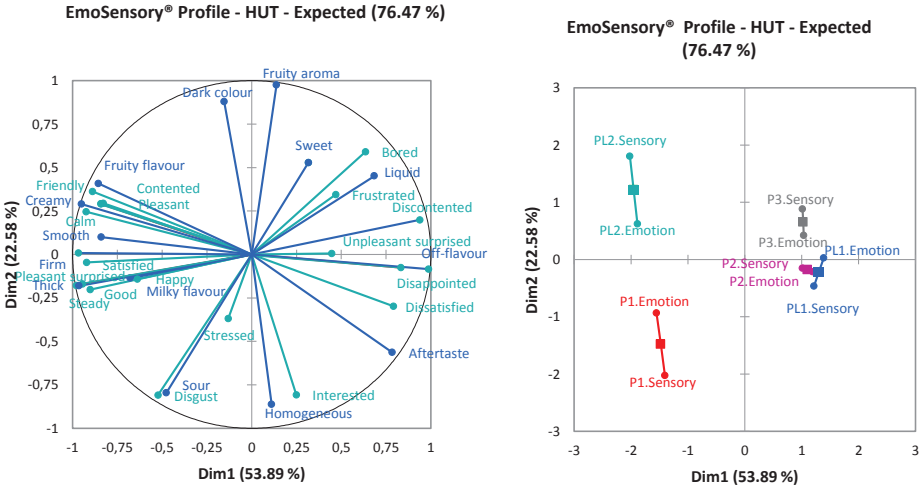

Figure 6.6 Representations of terms (a) and products (b) in the first two dimensions of MFA (HUT – expected condition)

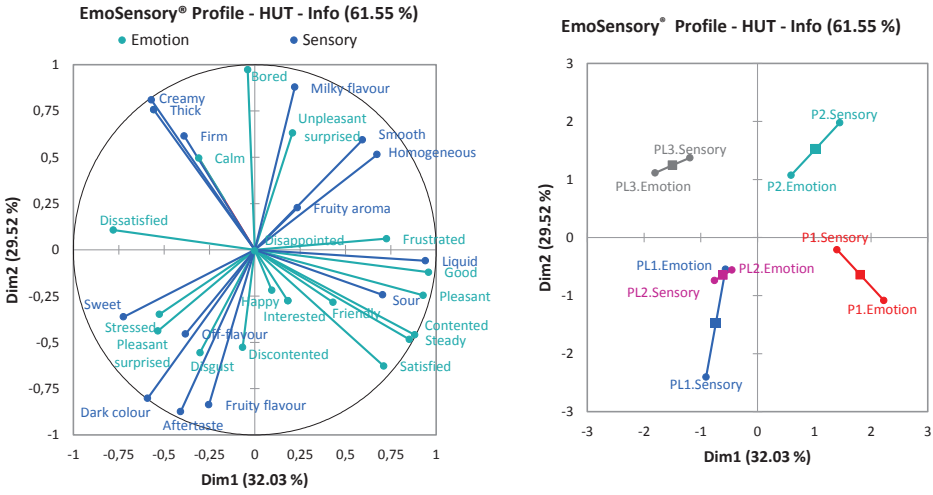

Figure 6.7 Representations of terms (a) and products (b) in the first two dimensions of MFA (HUT – informed condition)

The configuration of the yoghurt samples in the MFA dimensions under the blind condition is depicted in Figure 6.5b. In general, the distance between the emotional and sensory representation of the products is not that short, which is also reflected in the RV coefficient of 0.60. The five product samples are rather spread throughout the two dimensions, indicating that they are associated with different emotional conceptualisations and sensory product attributes by the participants of the HUT under the blind condition. Under the expected condition, the configuration of the yoghurt samples is very similar to those obtained at the CLT test as we can clearly distinguish both premium brands separately and the private labels brands are tightly grouped together. The RV coefficient between the emotional and sensory data was 0.85 under the expected condition. Under the informed condition, an RV coefficient of 0.73 was found between the emotional and sensory data. Similar as under the blind condition, product configurations were rather scattered around the two dimensions under the informed condition. This is in contrast with the CLT, which shows that participants at a home use test might be evaluating the samples with a different mind-set.

6.3.2. The effect of context

6.3.2.1. Overall liking

First of all, the extent to which the research setting affected the overall liking was analysed under the three different conditions separately. When consumers evaluated the samples under blind or expected condition, no impact of the research setting on the overall liking scores was found (Table 6.7). A significant effect of the interaction between samples and setting on the overall liking scores was found under the informed condition, indicating that the influence of the location was not the same for all samples. Simple main effects were calculated and showed a significant effect of the location on the informed liking scores of samples P1 and PL2. The informed liking of both samples was higher when evaluated in the laboratory environment compared to the home environment.

Table 6.7 Two-way analyses of variance (n = 99) with interactions for Sample and Location data for each of the conditions separately

Condition	Source	F	df	p
Blind	Sample	3.587	4	0.007
	Setting	0.031	1	0.861
	Sample x Setting	1.586	4	0.177
Expected	Sample	31.206	4	<0.001
	Location	0.006	1	0.938
	Sample x Setting	0.240	4	0.916
Informed	Sample	2..213	4	0.067
	Setting	2.906	1	0.089
	Sample x Setting	2.618	4	0.034

6.3.2.2. Emotional profiling

Participants who conducted the profiling task in the CLT used a significantly larger number of emotional terms compared to users who performed the task at home during the expected and informed condition. No differences in the frequency of term use were found under the blind condition (Table 6.8a).

More emotional terms with significant differences among samples were found when the test was carried out in a laboratory setting (Table 6.8b). Also, more significant differences were found when taking the scores into account (RATA scoring) confirming results of previous research (Ares, Bruzzone*, et al.*, 2014).

The percentage of variance explained by the first two dimensions of the CA was at least 68% for all locations. Large differences were found under the blind conditions between the two contexts (Table 6.8c). Sample configurations were only similar during the expected conditions with RV values of 0.79 and 0.75 for respectively the RATA and RATA scoring analysing method. The RV coefficients between term configurations in the first two dimension were lower than the RV coefficients between sample configurations. Although the RV scores between the term configurations were rather low under all conditions, they reached significance under the blind and expected condition.

Table 6.8 Summary of the results for the comparison of the emotional profiling task with consumers obtained in a CLT setting (CLT, n = 53) and at home (HUT, n = 46) under the three experimental condition (blind, expected and informed)

	Condition		
	Blind	**Expected**	**Informed**
a. Term usage			
Average percentage of emotional terms used to describe samples	CLT: 17.2 HUT: 16.9	CLT: 14.4[a] HUT: 11.0[b]	CLT: 17.4[a] HUT: 14.1[b]
b. Sample differences			
Number of emotional terms with significant differences among samples ($p \leq 0.05$)	CLT - RATA: 3 CLT – RATA-S: 5 HUT - RATA: 0 HUT - RATA-S: 1	CLT - RATA: 9 CLT - RATA-S: 10 HUT - RATA: 1 HUT - RATA-S: 4	CLT - RATA: 2 CLT - RATA-S: 2 HUT - RATA: 0 HUT - RATA-S: 0
c. Sample configurations			
Percentage of variance explained by the first two dimensions	CLT - RATA: 81.2 CLT - RATA-S: 83.4 HUT - RATA: 74.4 HUT - RATA-S: 71.8	CLT - RATA: 79.0 CLT - RATA-S: 78.1 HUT - RATA: 80.2 HUT - RATA-S: 80.2	CLT - RATA: 68.0 CLT - RATA-S: 78.0 HUT - RATA: 69.9 HUT - RATA-S: 72.9
RV between sample configurations obtained from CA of emotion data from CLT and HUT	RATA: 0.57 RATA-S: 0.50	RATA: 0.79 RATA-S: 0.75	RATA: 0.50 RATA-S:0.41
RV between term configurations obtained from CA of emotion data from CLT and HUT	RATA: 0.31* RATA-S: 0.47**	RATA: 0.51*** RATA-S: 0.51***	RATA: 0.04 RATA-S: 0.13

RATA: indicates that the data were used based upon the frequency of selection ; RATA-S: indicates that the data were analysed by creating a summed index of the scores provided by all participants for each of the terms

[a,b] Term usage percentages with a different letter differ significantly between the scaling methods ($p \leq 0.05$)

*,**,*** Indicates that the RV coefficient is significant at $p \leq 0.05$, $p \leq 0.01$, $p \leq 0.001$

6.3.2.3. Sensory profiling

Participants selected more terms for the sensory profiling tasks during the blind and informed condition compared to the expected condition, regardless of the context. Further, participants who performed the test at the laboratory tended to use more sensory terms than those who executed the test at home during the expected and informed condition. However, similar to the frequency of emotional terms, it was the other way around under the blind condition where consumers at home tended to use more sensory terms for the sensory profiling task (Table 6.9a).

While the discriminatory capability of the sensory terms was highly similar under the informed condition, this was less the case under the blind and expected condition (Table 6.9b). Also, similar to the results of the emotional profiling, the discriminatory capability tended to be a bit higher when the intensity scores were taken into account confirming previous research (Ares, Bruzzone*, et al.*, 2014).

Percentage of variance explained by the first two dimensions of the CA was higher than 70% in each case (Table 6.9c). All the RV coefficients obtained by comparing the sample configurations between the sensory profiles of the both research settings were significant and high values were obtained as the lowest RV score was 0.82. While the RV coefficients were lower for the term configurations compared to the product configurations, all RV coefficients were still significant.

Table 6.9 Summary of the results for the comparison of the sensory profiling task with consumers obtained in a CLT setting (CLT, n = 53) and at home (HUT, n = 46) under the three experimental condition (blind, expected and informed)

	Condition		
	Blind	**Expected**	**Informed**
a. Term usage			
Average percentage of sensory terms used to describe samples	CLT: 33.9[a] HUT: 35.7[b]	CLT: 27.4[a] HUT: 21.0[b]	CLT: 34.8[a] HUT: 28.9[b]
b. Sample differences			
Number of sensory terms with significant differences among samples ($p \leq 0.05$)	CLT - RATA: 6 CLT - RATA-S: 8 HUT - RATA: 5 HUT - RATA-S: 4	CLT - RATA: 7 CLT - RATA-S: 8 HUT - RATA: 4 HUT - RATA-S: 5	CLT - RATA: 7 CLT - RATA-S: 9 HUT - RATA: 9 HUT - RATA-S: 10
c. Sample configurations			
Percentage of variance explained by the first two dimensions	CLT - RATA: 83.1 CLT - RATA-S: 83.7 HUT - RATA: 79.5 HUT - RATA-S: 86.5	CLT - RATA: 92.0 CLT - RATA-S: 95.4 HUT - RATA: 85.6 HUT - RATA-S: 89.4	CLT - RATA: 71.5 CLT - RATA-S: 90.3 HUT - RATA: 81.9 HUT - RATA-S: 75.2
RV between sample configurations obtained from CA of sensory data from CLT and HUT	RATA: 0.95*** RATA-S: 0.95***	RATA: 0.90*** RATA-S: 0.94*	RATA: 0.89*** RATA-S: 0.82**
RV between term configurations obtained from CA of sensory data from CLT and HUT	RATA: 0.49** RATA-S: 0.58***	RATA: 0.63*** RATA-S: 0.51**	RATA: 0.52** RATA-S: 0.62***

RATA: indicates that the data were used based upon the frequency of selection ; RATA-S: indicates that the data were analysed by creating a summed index of the scores provided by all participants for each of the terms

[a,b] Term usage percentages with a different letter differ significantly between the scaling methods ($p \leq 0.05$)

*,**,*** Indicates that the RV coefficient is significant at $p \leq 0.05$, $p \leq 0.01$, $p \leq 0.001$

6.4. Discussion

This study examines the influence of brand information and context on the overall liking, sensory and emotional profiling of yogurt brands under three evaluation conditions. The results of this study revealed that both brand information and context influenced the overall liking, sensory and emotional profiles but the impact differed between the presentation conditions.

Only a small number of emotional terms were discriminating between both samples, which makes it hard to know if the research setting played a role in the discriminability of the emotional terms. The limited discriminative ability of the emotional terms might be the result of either the product category or the used samples as the average percentage of emotional terms used by consumers in this study was similar to those reported in other studies (King *et al.*, 2013; Piqueras-Fiszman & Jaeger, 2014a). Danner *et al.* (2016) examined the influence of the three different contexts (home, laboratory and restaurant context) on the emotional profiling of wine. This study found that participants associate more intensively positive emotions (e.g. happy, enthusiastic, adventurous) when evaluating wine samples at a restaurant compared to at home or in a laboratory environment. There are little differences reported in emotional profiling between the home and laboratory environment, which is in line with the findings of this study. Participants in the aforementioned wine study were all rather familiar with the product, just as in this study, which might have impacted the results. Furthermore, several studies showed that the evoked context and appropriateness could influence the emotional profiling of food products (Dorado, Chaya, Tarrega, & Hort, 2016; Piqueras-Fiszman & Jaeger, 2014b, 2014c). The low RV scores for sample and emotional term configurations between the CLT test and HUT indicate that consumers might conduct the emotional profiling task under a different mind-set. As previous research found that an imaginary evaluation context could influence the emotional profiling task (Piqueras-Fiszman & Jaeger, 2014a, 2014b, 2014c), it might be interesting to examine if such imaginary context could lead to a similar emotional profile as obtained under a realistic HUT.

While the discriminability of the sensory terms was very similar under the blind and informed evaluation during the CLT, the informed condition yielded more differences in selected terms compared to the blind condition during the HUT. This suggests that the influence of the research setting on the performance of the sensory profiling task might be depending on the evaluation condition. This study found rather similar term and sample configurations of the sensory profiling for both research settings, although one should note that most RV values were rather low. Therefore, more studies across different product categories and also different contexts (e.g. malls, grocery stores, restaurants, imaginary context or even virtual context) are necessary to confirm these findings.

This study also shows that premium brands generally generate higher scores for expected liking compared to the blind and informed conditions, indicating that extrinsic cues increase hedonic expectation. However, only an assimilation effect occurred for sample P1 when evaluated in the laboratory environment. As the informed liking scores tended to be closer by

the blind liking scores than the expected liking scores, consumers' informed liking scores appeared to be primarily influenced by the sensory characteristics rather than the brand information regardless of the brand was premium label or private label. This is in contradiction with results of several other studies examining the influence of brand on the overall liking which concluded that brand information influenced liking scores (Fernqvist & Ekelund, 2014). However, studies described in this review paper, tended to work with whole packages which was also the case for the only study involving yoghurt products (Paasovaara *et al.*, 2012). Therefore, it is not clear to which extent it was actually the brand which influenced liking scores as even the type of image (Mizutani *et al.*, 2010) or the package colour (Piqueras-Fiszman & Spence, 2011) might influence overall liking scores.

There were little differences between the blind and informed ratings of the emotional conceptualisations, suggesting that emotional conceptualisations are mainly sensory-driven which is in line with previous research results (Gutjar, Dalenberg*, et al.*, 2015; Ng *et al.*, 2013b; Schouteten *et al.*, 2015a; Spinelli *et al.*, 2015). Although brand information only played a secondary role on the emotional profiling, more research is needed that involves other product categories.

Brand information also affected the sensory profiling of the samples, but this was mainly the case for the tests carried out at home. For instance, the intensity of the sweet taste of one of the premium brands (P1) was experienced as lower under the informed condition at home. This supports findings that information such as brand, content information, health information and package could alter sensory perception (Cavanagh & Forestell, 2013; Schouteten *et al.*, 2015a; Schouteten *et al.*, 2016; Stolzenbach, Bredie, Christensen, & Byrne, 2013; Vidal, Barreiro, Gómez, Ares, & Giménez, 2013). Further, results showed that the informed sensory profiling of the samples was more similar to the expected condition than the blind information. Although this was the case for both the HUT and CLT, the similarity was more pronounced at the HUT. It might be that social interaction played a role as consumers are tended to be more influenced by the brand information compared to the more individual evaluation at the CLT during this experiment (King, Weber, Meiselman, & Lv, 2004).

The context had only an effect on the overall liking when consumers received brand information. Most previous studies indicated that the testing location influences the hedonic assessment (Boutrolle *et al.*, 2005; Daillant-Spinnler & Issanchou, 1995; Hellemann, Mela, Aaron, & Eleri Evans, 1993; Kozlowska *et al.*, 2003), similarly as in willingness-to-pay research (De Steur *et al.*, 2014), but some studies reported no differences (Hersleth *et al.*, 2005; Pound, Duizer, & McDowell, 2000). It is interesting to note that the overall liking scores for 2 samples was higher at the CLT than HUT whereas the majority of the other studies reported frequently lower liking scores at the CLT test (Boutrolle *et al.*, 2007; Daillant-Spinnler & Issanchou, 1995; Hellemann *et al.*, 1993; Kozlowska *et al.*, 2003). While Boutrolle *et al.* (2007) suggests that the different results might be explained by the product type or methodology of the study, this study indicates that one should also bear the evaluation condition (blind, expected, informed)

in mind as a potential influence on the overall liking when comparing results obtained at different testing locations. Nevertheless the differences for two samples, liking scores of the other samples did not differ between the HUT and CLT. Hersleth *et al.* (2005) lists several possibilities why the overall liking scores of products might be similar although products are evaluated under a different context. One of the possibilities is the familiarity of the type of products, which is a factor which should be considered as only yogurt product-users were considered eligible for participating in this study. Further, it is also suggested that well-known and well-liked food products are less susceptible for the effect of changing contexts (King, Meiselman, Hottenstein, Work, & Cronk, 2007).

HUT is a more natural eating situations which differ from the controlled eating situation in the laboratory environment (CLT) in several ways. This could have affected the hedonic scores, emotional and sensory profiling of this study. One potential factor is the time of the day. It is more likely that the time of consumption will be more appropriate for a consumer when he or she has the opportunity to choose it during a HUT compared to when the consumer needs to evaluate the sample at a fixed time during a CLT (Boutrolle *et al.*, 2005). Time of consumption might not only influence the overall liking, but also impacts the sensory profiling as the psychological state might be different which could influence sensory perception. Related to this, the desire to eat the product is also expected to be higher during a HUT compared to CLT (Boutrolle *et al.*, 2005; Boutrolle *et al.*, 2007) which might impact the emotional profiling task. Further, it has been suggested that a standardized CLT context could induce a more analytical mind-set as it resembles more as a real experiment compared to a test at home (Boutrolle *et al.*, 2005). Consumers are also more likely to pay more attention during a CLT, which might explain the higher discrimination between the samples compared to the HUT found in this study. It is also possible that social interaction occurred at the HUT while this is discouraged when evaluating products in separate booths at a CLT (Hersleth *et al.*, 2005). Future research could opt to ask for a description of the contextual factors in order to make a more thorough comparison possible of potential factors influencing the hedonic liking, emotional and sensory profiling of food products.

Combining the emotional and sensory profiling might offer a better understanding on the relationships between both profiles. It is clear that the combined profiles offer new consumer insights which might not be clear when only assessing the hedonic liking. For instance, the results of the informed laboratory condition suggest that the sensory terms 'fruity flavour' and 'fruity aroma' are highly correlated to the two emotional conceptualisations 'friendly' and 'contented'. This information can be of interest for the SensoEmotional optimization of the product (Thomson, 2007). It is for instance possible to market the corresponding brands so that people attach the products with the conceptualisations 'friendly' and 'contented'. These linkages between emotional and sensory terms might not only be of interest for marketing purposes, but also for food product development (Thomson, 2007). When it is known that a certain brand is linked with specific emotional conceptualisations, it is possible to develop or

refine a product so that the sensory characteristics are in line with these conceptualisations. If both the sensory and are in congruence, this will strengthen the product experience and providing a benefit compared to competitors' products.

Consumers assessed their hedonic liking before conducting the EmoSensory® Wheel task. Although this in line with research of King *et al.* (2013), it is unclear to what extent the hedonic liking might have influenced the profiling task. The present study worked with 5 samples which is more than the number of 2-3 samples recommended in emotional research (King *et al.*, 2013). However, the necessary precautions were undertaken in this study (e.g. small portion size, cleanse palate,…) and other studies have worked with a similar number of samples (Gutjar, Dalenberg*, et al.*, 2015; Ng *et al.*, 2013b; Spinelli *et al.*, 2015). Further, this study examined the differences between the HUT and CLT context using a between-subjects design as applied in several other studies (Boutrolle *et al.*, 2005; Boutrolle *et al.*, 2007; Edwards *et al.*, 2003). However, one need to bear this in mind when interpreting the results and future research could opt to work with a within-subject design in order to avoid potential inter-panel differences when examining context effects. Both emotional and sensory term lexicons used in this study were generated by consumers as suggested in previous research (Ng *et al.*, 2013a; Thomson, 2007). This study has opted not to work with a standardized emotion questionnaire as these might contain too many items to ensure that no important terms are missed which can has negative consequences on the collected data due to boredom and fatigue (Jaeger, Cardello*, et al.*, 2013; Ng *et al.*, 2013a; Spinelli *et al.*, 2015). Nevertheless, the question arises if the same conclusions could be drawn when for instance a standardized emotional list such as the EsSense Profile ™ (King & Meiselman, 2010) or a sensory lexicon generated by expert panellists. Also, the terms in this study were scaled using the RATA approach (Ares, Bruzzone*, et al.*, 2014). Further research is needed with other scaling methods like CATA and intensity scales to confirm the current findings. While it is known how consumer attitudes (Villegas, Carbonell, & Costell, 2008), frequency of use (King & Meiselman, 2010) and familiarity (Carrillo, Varela, & Fiszman, 2012; Lahne, Trubek, & Pelchat, 2014) might play a role on the hedonic assessment, emotional and sensory profiling, further research is recommended to which extent such effect might be influenced by the evaluation context. The technological advances also raises possibilities to break down the walls between the standardized (CLT) and more realistic setting. The use of immersive settings but also new material like 3D glasses advances possibilities for interesting future research (Bangcuyo *et al.*, 2015; Jaeger *et al.*, 2016).

In conclusion, both brand information and context may – under certain conditions – influence the sensory and emotional of food products. The context mainly affects the emotional profiling of food products while there was little impact on the sensory profiling and overall liking. On the other hand, brand information mainly influenced the sensory profiling while there was little impact on the emotional profiling and overall acceptance. Further, testing under the three evaluation conditions (blind, expected and informed) can be important in order to obtain a better understanding of the product performance. This makes it possible to detect for instance

discrepancies in profiling under the different evaluation conditions which can be of interest for the SensoEmotional optimization of food products (Thomson, 2007). As such, researchers and industry should consider the potential impact of the context and evaluation condition when setting up experiments involving emotional and sensory profiling of food products.

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Part IV

General discussion

Chapter 7

General discussion and conclusions

The previous parts and chapters have profoundly discussed study-specific findings and implications in detail. This final part (Part IV) provides a more general discussion of the main findings and conclusions in light of the proposed conceptual framework (Figure 1.9) presented in Chapter 1.

The research objectives and hypotheses are revisited based upon the results presented in the different research chapters in the first section (7.1). Then, the second section (7.2) provides a general discussion of the research results and their scientific implications, societal and food industry relevance are provided. The final section (7.3) acknowledges the limitations of this doctoral research and proposes directions for further research based on these limitations and the findings.

7.1. The research objectives and hypotheses revisited

The overall objective of this doctoral research was to examine the role of information and context on consumers' food product experience. Obtaining a broader view than merely the hedonic assessment must make it possible to better understand what really thrives consumers' food choice and is therefore of interest for the development and promotion of nutritionally balanced food products. However, due to the lack of a consumer-friendly questionnaire format to capture consumers' food product experience, a new method has been developed and validated in this PhD. This method, the EmoSensory® Wheel, has been applied in three separate case studies (part III) in order to investigate the influence of the separate cues as described in the conceptual framework (Section 1.3.5). Based on the framework, two research objectives and 6 main hypotheses were formulated (Section 1.5) which are discussed in the following subsections.

7.1.1. Research objective 1: Development and validation of the EmoSensory® Wheel

The first research objective has been dealt with in Part II, discussing the development and validation of the EmoSensory® Wheel in order to assess food product experience with a consumer-friendly method. The second chapter described the development as well as discriminatory ability of this method. The discriminatory ability was assessed between product categories (crisps, chocolate and cola beverage) and within product categories (burgers and vanilla pudding desserts). A part of the consumers assessed the tool under an informed condition, written brand information was given, in order to examine if the tool can also be applied when information is provided.

H1: The application of the EmoSensory® Wheel by consumers enables discriminating and sensory profiles of food products.

The results of chapter 2 showed that this new method can be applied to obtain discriminatory emotional profiles between products of different food categories. Also, results with the burger and vanilla pudding illustrated that the EmoSensory® Wheel can also be used to detect differences in emotional and sensory profiles when samples of the same product category are used which is of course the most interesting capability. Previous research with the traditional, list-based questionnaire formats already demonstrated that it is possible to obtain discriminatory emotional and sensory profiles within a product category for a wide range of food products (Jiang, King, & Prinyawiwatkul, 2014; King & Meiselman, 2010; Ng, Chaya, & Hort, 2013b; Varela & Ares, 2012). Results described in the other chapters exhibited that the EmoSensory® Wheel is able to discriminate for chocolate (Chapter 3) and yogurt (Chapter 3 and 6) samples. Further, the tool is not only discriminative when consumers are evaluating the product samples without any information (blind condition) but also when consumers receive information (informed condition) such as brand name (chapter 2), health-related labels (chapter 4), ingredient information (chapter 6) and brand logo (chapter 6). In conclusion, this

illustrates the discriminatory validity (Carmines & Zeller, 1979) of the EmoSensory® Wheel and therefore the first hypothesis **H1** can be **confirmed**.

While the results described in Chapter 2 illustrated that the newly developed tool is able to discriminate food product experience between and within product categories, the question arises how the wheel format performs compared to the traditional list-based questionnaire format. Therefore, one experiment with two different product categories (chocolate and yogurt samples) were conducted in this doctoral thesis (chapter 3) to examine the convergent validity (Carmines & Zeller, 1979). The purpose of this experiment was twofold: (i) examine if the results obtained by both methods are similar and (ii) investigate how consumers perceive both methods for conducting the profiling task. Therefore, hypothesis H2 proposes that both questionnaire formats will lead to an equal assessment of the product experience:

H2: Consumers' emotional and sensory profiles of food products obtained by the EmoSensory® Wheel and list-based question format are equal.

The number of terms used was comparable for both formats and also in line with results reported from previous emotional and sensory profiling tasks (Ares *et al.*, 2014; King, Meiselman, & Carr, 2013). However, it is interesting to note that participants tended to use almost twice as much sensory terms compared to emotional conceptualisations terms during the task which might be due to the fact that the emotional profiling task is still a rather uncommon task for most consumers (Jaeger, Cardello, & Schutz, 2013).

The results presented in Chapter 3 found that the RATA response format was slightly more discriminative than the CATA format for the yogurt samples, while the CATA format was more discriminative for the sensory profiling when working with chocolate samples. However, one should note that for a large majority of the terms, both response formats lead to similar conclusions. This was also the main conclusion of Ares *et al.* (2014) though they reported that RATA could be slightly more discriminative than the CATA response format for certain product categories.

The high resemblance of both questionnaire formats is also illustrated by the RV coefficients. Although the RV coefficients for the sensory and emotional terms during the chocolate study were only average (values ranging from 0.57 to 0.71), all RV coefficients were significant. Further, the RV coefficients of the sample and term configurations were all high suggesting that the results of the profiling tasks were highly similar regardless of the applied questionnaire format.

In conclusion, the results of chapter 2 showed that the wheel question format yield similar results regarding the sensory and emotional profiling as when a list-based questionnaire format was used, regardless of the response format. This was the case for two different studies, so for both yogurt and chocolate samples. Therefore, hypothesis **H2** can be **partly confirmed** as there were differences in the discriminative capabilities of both questionnaire formats

according to the results discussed in chapter 3. However, one should note that the differences are rather small, so both questionnaire formats lead to very similar profiling results.

Although results showed that the wheel-based questionnaire format leads to similar sensory and emotional profiles as the traditional list-based questionnaire format, the question arises how consumers perceived both tasks. This is of particular interest because previous research found that consumers tend to find the emotional profiling task itself rather repetitive and boring which might affect the obtained results (Jaeger *et al.*, 2013).

H3: Consumers find the EmoSensory® Wheel at least as adequate as the list-based questionnaire format to perform the emotional and sensory profiling task.

Participants rated the easiness, tediousness and adequateness of conducting the profiling task similar for both questionnaire formats, suggesting that these measurements are only related to the task and are therefore not influenced by the questionnaire format itself. The perceived easiness and tediousness of the tasks were in accordance with those mentioned in other studies for conducting sensory profiling using the RATA scale (Ares *et al.*, 2014; Jaeger & Ares, 2015). When participants were asked which method they preferred, around two third of the participants chose the EmoSensory® Wheel. In general, participants found it a more novel way to collect data and some also mentioned that it provided a better overview compared to the traditional questionnaire format. Based upon the previously mentioned results, hypothesis **H3** can be **confirmed**.

The results related to hypothesis H2 show that the EmoSensory® Wheel generate similar findings about the food product experience compared to a traditional list-based questionnaire format. Therefore, it is interesting to examine if the newly developed EmoSensory® Wheel can also be applied in a similar methodological way when it is combined with the frequently used hedonic assessment. Because the hedonic assessment provides a global overview of consumers' acceptance of a food product, it is often included next to sensory or emotional profiling.

H4: The EmoSensory® profiling task does not influence the concurrent hedonic assessment.

A between-subjects design with two different food product categories (chocolate and yogurt) was set up in order to examine this hypothesis. Results, as discussed in Chapter 3, found no significant effect of conducting the profiling task using the EmoSensory® Wheel on the overall hedonic liking. This was neither the case when the RATA or CATA scaling approach was applied. Previous studies found that there is rather a limited influence on the hedonic assessment when conducting either emotional (Gutjar, de Graaf, *et al.*, 2015; King *et al.*, 2013) or sensory profiling (Jaeger & Ares, 2014, 2015) using a list-based questionnaire format, mainly when a larger number of samples are used. Hence, hypothesis **H4** can be **confirmed**.

7.1.2. Research objective 2: Understanding to which extent information and context might influence product experience

The second research objective is related to the ecological validity when conducting sensory research. Two important dimensions of *ecological validity* are (i) the *nature of stimuli* and (ii) the *nature of the research setting or context* (Schmuckler, 2001). As the major focus lies on how consumers perceive the sensory attributes, sensory evaluation is traditionally carried out with so-called blind-labelled samples using a random 3-digit code (Lawless & Heymann, 2010). However, consumers are in the real word influenced by both extrinsic and credence cues such as brand, price, organic labels which may alter their sensory perception (Fernqvist & Ekelund, 2014; Liem, Toraman Aydin, & Zandstra, 2012; Piqueras-Fiszman & Spence, 2015). Further, most sensory research is carried out in a laboratory setting in order to make the testing as standardized as possible (Lawless & Heymann, 2010). But one might assume that food product experience will differ when one evaluate the product in a more realistic context like home or in a restaurant (Jaeger *et al.*, 2016; Meiselman, 2013). Based upon this, the second research objective wants to examine if extrinsic cues, credence cues and context influence the food experience assessed by the EmoSensory® Wheel.

Although several studies have shown that the package influences the emotional profiling of food products (Gutjar, Dalenberg*, et al.*, 2015; Ng *et al.*, 2013b; Spinelli, Masi, Zoboli, Prescott, & Monteleone, 2015), little is known on the effect of specific extrinsic and credence cues. There is also a lack of information about the influence of specific cues on the sensory profiling of food products by consumers as research primordially focuses on the overall hedonic assessment (Piqueras-Fiszman & Spence, 2015). Therefore, three experiments (chapter 4, 5, 6) were conducted in order to examine the impact of the nature of the stimuli on the food product experience by providing information cues.

Given the weight of health aspects for Belgian consumers' food choice (Januszewska *et al.*, 2012) and because it is of interest for policy makers given the current raise in obesity in developed countries, the first case study involved health-related label information cues. As the purpose was to really examine the influence of these cues, participants were presented with the same product (young gouda cheese) but accompanied with different information claims in this experiment.

H5a: The presence of health-related labels generates a more positive emotional profiling and impacts sensory profiling.

Results presented in chapter 4 indicated that more consumers associated emotional conceptualisations in cheese negatively when cheese was provided with a health-related label such as 'light' or 'reduced salt' under the expected condition. However, when they tasted the same cheese but accompanied with different labels, there was almost no difference regarding the emotional profiling between the labelled cheeses. A possible explanation might be that participants associate healthy food as rather 'untasty' as mentioned in previous research (Mai

& Hoffmann, 2015) and illustrated by the results of the emotional profiling in the expected condition in this study. Given that there was almost no influence of the labelling on the emotional profiling when tasting the cheese products, it can be concluded that emotional profiling is primarily sensory driven which is in line with studies using whole packages as information (Ng *et al.*, 2013b; Spinelli *et al.*, 2015). The fact that we little impact of health-labels on the informed emotional profiling was found is in contradiction with results of Lagerkvist, Okello, Muoki, Heck, and Prain (2016). They reported a positive impact of health information on the emotional profiling of vitamin-A bio fortified orange-fleshed sweet potato by caretakers and pregnant women. Regarding the sensory profiling, consumers tended to alter the sensory perception of attributes related to the specific health-related labels (e.g. salt when a 'reduced salt' label was used) although they were actually evaluating the same gouda cheese. In short, hypothesis **H5a** can only be **partially confirmed** as the influence of the emotional profiling was limited to the expected condition.

The second case study examined the influence of providing information about the main ingredient on the food product experience. This experiment, described in full detail in Chapter 5, worked with three burgers: (i) plant-based, (ii) meat-based and (iii) insect-based. The inclusion of the insect-based burger makes it possible to also apply the tool with a rather new food product for most Belgian consumers (Verbeke, 2015).

H5b: Emotion and sensory profiles are to a larger extent influenced by information about containing ingredients made from insects compared to information about plant-based and meat-based ingredients.

Although it was expected that information altered at least the emotional profiling of the insect burger, results revealed that the impact was very limited for the insect-based burger. Reason could be that the sample consisted mainly out of young adults which tend to have a more positive view about insect-based food products (Verbeke, 2015). The emotional profiles of the three burgers when providing information resembled highly the profiles obtained when they evaluated the samples without any information, which supports previous findings that the sensory properties of food products are the major driver for emotional conceptualisations (Ng *et al.*, 2013b; Schifferstein, Fenko, Desmet, Labbe, & Martin, 2013; Spinelli *et al.*, 2015). When looking at the MFA plot comparing the product positions in the emotional space, the insect-based position is even closer between the informed and blind condition compared to the meat-based and plant-based burgers. Regarding the sensory profiling, information only altered the sensory profiles for three attributes of the plant-based burger ('granular', 'meat flavour' and 'off-flavour') and only for one sensory attribute of the insect-based burger ('meat flavour'). MFA indicates that the product position in the sensory space are very similar under the blind and informed condition. In summary, given that the effect of information on the emotional profiling was even smaller for the insect-based burger compared to the plant-based burger and there was little impact of information on the sensory profiling, hypothesis **H5b** can be **rejected**.

The last case study (chapter 6) involved brand information as an extrinsic cue. Little information is available about the influence of brand on either sensory and emotional profiling of food products (Gutjar, Dalenberg*, et al.*, 2015; Piqueras-Fiszman & Spence, 2015) while it appears that brand information influences the overall acceptance of several food products (Fernqvist & Ekelund, 2014). An experiment was undertaken with five strawberry flavoured yogurt samples including 2 premium brands and 3 private label brands.

H5c: The provision of premium brand information results in a more positive consumers' emotional profiling compared to the blind evaluation.

Brand information had only an influence on the emotional profiling of one private label sample and not on the four other samples. Several studies reported that package had a rather small impact on the emotional profiling of blackcurrant squashes (Ng *et al.*, 2013b), hazelnut / cocoa spreads (Spinelli *et al.*, 2015) and breakfast drinks (Gutjar, Dalenberg*, et al.*, 2015). While P1 has a significantly higher overall liking when consumers are informed about the brand, it appears that this higher overall liking is not reflected in the informed emotional profiling of this yogurt sample. Further, a larger effect of brand information was found on the sensory profiling of yogurt samples. For instance, the perceived intensity rating of several attributes such as sweetness, fruity flavour and fruity aroma were influenced by the brand information. Based upon these results, hypothesis **H5c** can be **rejected**.

In conclusion, experiments described in Chapter 4, 5 and 6 indicated that individual extrinsic and credence cues mainly influenced the sensory profiling while there was little effect on the emotional profiling. Although there was apparently little influence on the emotional profiling, one should bear in mind that the tool was able to distinguish different emotional sensory profiles of the samples in the burger and yogurt experiment while some samples had a comparable overall liking.

The experiment with yogurt samples (Chapter 6) has been carried out at two different locations: (i) CLT and (ii) HUT. The purpose of testing at two different locations was to examine to which extent the context might influence the product experience as measured by the EmoSensory® Wheel.

H6: Consuming food within a lab context leads to more discriminating emotional and sensory profiles compared to evaluation at home.

The results confirmed that the context influences both the emotional and sensory profiling of the food experience for strawberry flavoured yogurt samples. That was the case for all three evaluation conditions (blind, expected and informed). Previous research found that the context could influence the overall acceptance of food products (Boutrolle, Delarue, Arranz, Rogeaux, & Köster, 2007; Edwards, Meiselman, Edwards, & Lesher, 2003; Mouta, de Sá, Menezes, & Melo, 2016) and several studies showed that the (evoked) context could alter the emotional profiling of food products (Danner *et al.*, 2016; Piqueras-Fiszman & Jaeger, 2014a, 2014b, 2014c). But

the results presented in chapter 6 demonstrate that the context not only impacts the overall acceptance but might also influence the emotional and sensory profiling. However, it should be mentioned that the context mainly influenced the emotional profiling while the impact on the sensory profiling was rather limited. Hence, hypothesis **H6** can be **confirmed**.

7.2. General discussion and implications

The sensory evaluation of food products is essential to obtain a good understanding of how consumers perceive food products. This is not only the case for food companies, which perform sensory tests during food product development, but also for scientists who examine food choice. Nowadays, the evaluation of food products by consumers is often limited to the assessment of the overall acceptance. This has the disadvantage that it is not always possible to gather a thorough understanding about what thrives consumers' food product choice. It is for instance not clear why products with a similar overall liking are more or less preferred by consumers. Emotional and sensory profiling could delve deeper into consumers' motivations of food acceptance but there is currently lack of an appropriate method for the combined elicitation of emotional and sensory profiling. Therefore, this thesis developed and validated a new method (EmoSensory® Wheel) to obtain a broader view of consumes' food product experience by combining emotional and sensory profiling. This sections provide a brief general discussion and also includes some general implications. A more detailed discussion and implications of each study can be found in the previous chapters of part II and part III.

The studies presented in this doctoral thesis illustrated that this method can help to **discriminate** between and within food product categories regarding their emotional and sensory profiles. By obtaining such profiles, **scientists** and **food companies** could have a more clear look on what *discriminate* one product from another which ultimately might help to better **understand food choice**.

Scientists can apply the EmoSensory® Wheel to food products in a similar way as current emotional and sensory profiling methods. However, the advantage lies in the fact that consumers experience the profiling task as a more 'fun' thing to do which might make **data collection easier** compared to traditional methods which are sometimes perceived as boring (Jaeger *et al.*, 2013). Obtaining both emotional and sensory methods might enhance the insights on how consumers experience food products. The obtained profiles might help to obtain a better **understanding** regarding on what thrives **food choice** which is of interest for scientists to tackle various global challenges such as global health and food security problems. A more practical example of how the EmoSensory® Wheel can be applied to encounter those global problems is given in this doctoral thesis by the case study of health-related labels (Chapter 4) and insect-based burgers (Chapter 5).

The EmoSensory® Wheel can be of use to *food companies*, in line with the conceptual framework, on two different levels: (i) **food product development** and (ii) **marketing**. Because consumer-led food product development is seen as an interesting approach to lower the high product failure rates (Costa & Jongen, 2006), the incorporation of emotional and sensory profiles obtained by the EmoSensory® Profile will certainly enhance this process by adding more value to the voice of the consumer. The EmoSensory® profile can be applied in different stages of the food product development, as this doctoral thesis has illustrated its added value

under blind, expected and informed evaluation conditions. The tool can also be used for the SensoEmotional optimization which is defined as ensuring that the sensory properties are in line with the (emotional) conceptualisations consumers associate with the (branded) product (Thomson, 2007). When both are in accordance, this will strengthen the product message which is expected to lead to a better overall product appreciation (Thomson, Crocker, & Marketo, 2010). The *SensoEmotional optimization* can be used in two ways: (i) adapting the product formulation by food product development and / or (ii) adapting the emotional conceptual profiling by marketing. When it is clear that certain main sensory attributes are associated with specific emotional conceptualisation(s), a food producer can use this information for marketing purposes in order to enhance product experience and to differentiate from competitors' products. The most common example on how to use emotional conceptualisations as a marketing tool is of course 'happiness' by the Coca-Cola® brand.

However, it should be noted that the possibilities and limitations of the newly developed method should discussed which are mainly related to the software. The current tool is constructed within the commercial sensory software package EyeQuestion software (Logic8 BV). Although this has the advantage that the tool can be more widely available, it comes at the cost that the improvement of this method will need to be performed by this company. A current limitation is the fact that the construction of the wheels still needs coding in XML which requires some expertise although a small manual has been provided by the company. Further, it is now possible (since an update earlier in 2016) to determine the size of the wheel. One should also understand that it is at this moment not possible to randomize the order of the terms in the wheel questionnaire format. Although research showed that term order had little impact on the sensory and emotional profiling of food products (Ares et al., 2013; King, Meiselman, & Carr, 2013), one should consider this as a limitation of the current tool. However, using the same term order for all samples has the advantage that it reduce the answer time for a participant to complete the profiling task when working with several samples. Further, one could use the CATA response format for the tool but a participant always need to 'confirm' every term (s)he checks which makes that the overall time for completing the task is longer compared when one could only click the applicable terms without confirmation. Given that the wheel-based questionnaire format can actually rotate, this could make it a more attractive way for data collection compared to a traditional tool especially when working with mobile devices. But the fluentness of the rotating also implicates some hardware requirements. Lastly, one should also consider that the tool is software-based, thus using the tool on paper is not possible in its current form. The software is web-based, but it is also possible to use it offline.

This doctoral thesis studied the **influence** of **information and context** on consumers' food experience. Literature on the influence of specific cues e.g. brand, price, … on the emotional and sensory profiling is rather scarce as previous studies worked with the whole package (Gutjar, Dalenberg*, et al.*, 2015; Ng *et al.*, 2013b; Spinelli *et al.*, 2015). Sensory research tend to be performed in a central location, generally in a standardised laboratory environment, by

which the question arises to which extent obtained profiles resemble those of a more realistic food consumption context such as at home (Jaeger *et al.*, 2016). Information and context influences are related to the ecological validity of the tests as it questions if the same results would be obtained in a more natural environment (Schmuckler, 2001). Three case studies were included in this doctoral studies which are of interest for scientists, policy makers and food industry.

The first case study (Chapter 4) examined the **influence of health-related labels**, a credence attribute cue, on the food product experience. Results demonstrated that mainly the 'light' label had a negative connotation while there was little impact of the 'reduced in salt' label. Further, the sensory perception of the attributes differed according to the labels (e.g. salt for 'reduced in salt' and fat for 'light), even though consumers were actually evaluating the same cheese. The occurrence of a so-called halo effect is important information for *scientists* and *food companies*. They should take this effect into account when they let consumers evaluate labelled products. For instance, this effect should be considered when consumers are perceiving a beverage with sweetener as less sweet than a regular beverage when trained panellists are not able to detect any differences. Further, results indicate that specific health-related labels might be used as a marketing tool in order to target specific health-oriented consumers which are of interest for food companies. The findings also show the potential for using health-related labels for priming towards more healthy food choices which should be examined by scientists but is of course also of interest for *food policy makers*. Because it is not easy to alter consumer opinions, one should examine the possibility to work with a more overall health logo such as in the Netherlands (Liem *et al.*, 2012). This study worked with *deception* and no feedback was afterward provided for the participants. From an ethical point of view, the question arises if such feedback is necessary in future studies performed within an academic setting. Related to this, it should be mentioned that all studies included in this doctoral thesis were performed following guidelines proposed by the medical ethical committee of Ghent University. Although there have been changes regarding the ethical approval for sensory studies over the course of this doctoral thesis, it might be interesting for the faculty of Bio-science engineering to include the ethical assessment of sensory and consumer tests in its ethical committee similar to the Faculty of Economics and Business Administration of Ghent University to enhance the process of ethical approval for conducting sensory research.

The influence of **ingredient information** on consumers' emotional and sensory profiling of burgers was the topic of the second case study (Chapter 5). This study compared the evaluation of an insect-based and plant-based burger with those of a meat-based burger which is interesting as insect-based food products are considered as a potential food source in order to establish food security on a global level (FAO, 2013). This study found that the primarily focus for sustainable alternatives for meat-based products such as plant-based and insect-based foods should be on the sensory composition. Although consumers were willing to try

such products, participants were not keen of the current commercial plant-based and insect-based burgers which could jeopardise future consumption of such products. Food companies should focus on the optimisation of the composition of such products which will alter the perception of the sensory attributes. This will not only affect the overall liking, but will also influence the emotions evoked by the consumption of the burgers. Further, it was interesting to note that the emotional conceptualisation 'fear' was almost absent when consumers were informed about the insect-based burger indicating that participants might be ready to consume insect-based products if the taste is good. The fact that the overall acceptance of the insect burger was higher when consumers knew that it was made with insect also support the idea that the participants, mainly young people, were ready to adopt insects as proposed by Verbeke (2015). Nevertheless, attention should also be paid to the high number of negatively valenced emotional terms associated with the insect-based product under the expected condition. This advocates the need for a higher public awareness of insect-based products which might be a task for government agencies such as the Vlaams Centrum voor Agro-en visserijmarketing (VLAM) in Belgium.

The third and last case study involved the influence of **brand information** on the food experience of yogurt conducted at **CLT and HUT**. In accordance with the first two case studies, the brand information mainly influenced the sensory profiling while it had only a limited impact on the emotional profiling of the samples. The context affected principally the emotional profiling. These results are of methodological importance when one want to conduct sensory and emotional profiling of food products, which is of course relevant for both *scientists* and *food industry*.

In conclusion, both information and context may – under certain conditions – influence consumers' food product experience. Conducting tests under different **evaluation conditions** (blind, expected and informed) makes it possible to even detect additional discrepancies between the emotional and sensory profiling of food products which can contribute to the SensoEmotional optimization of food products (Thomson, 2007). Based upon the presented results, *researchers* and *food industry* should consider the **ecological validity** before setting up an experiment and when interpreting the findings of emotional and sensory profiling tests. Sufficient attention needs to be paid to the presentation of the stimuli and context of the sensory tests in order to obtain meaningful results.

7.3. Limitations and future research perspectives

A new tool, the EmoSensory® wheel, has been developed, validated and applied in this doctoral thesis in order to obtain a better and broad understanding on how consumers experience food product. Further, the results of this doctoral research contribute to the improvement of the ecological validity of sensory research by examining how information and context might influence consumers' food product experience. Nonetheless, the choice for a specific research design and methodology has imposed some limitations which are thoroughly discussed in the Chapters 2-6. As some of these limitations provide interesting directions for future research, this section will focus on general limitations, which are mainly inherent when conducting sensory research.

A first limitation is related to the **method** applied for determining consumers' food product experience namely the EmoSensory® Wheel. While the validation and methodological implications of this method has been discussed in depth in this doctoral thesis (Chapter 2 and 3), one still needs to consider several choices inherent when choosing a research method. First of all, we opted to work with *alphabetically listed terms* in order to ease the response process of consumers. Although previous studies found little influence of term order on the emotional and sensory profiling (Ares & Jaeger, 2013; King *et al.*, 2013), one should keep this in mind. During each case-study, we have opted to work with the *RATA scale* in order to obtain intensity ratings. However, the RATA scale asks a little more effort and might also induce a more analytical way of responding to questions. But two studies, one with chocolate and one conducted with yogurt products, presented in Chapter 3 found little influence of the scale response format on the emotional and sensory profiling of food products. Further, *consumer-generated term lists* were used during each case-study. The use of first selecting the terms with consumers has two main advantages over more standardized lists (such as the EsSense profile™ for emotional terms): (i) less terms are necessary which reduces response time and (ii) they tend to be more discriminative. This has been pointed out for emotional terms (Ng, Chaya, & Hort, 2013a) but still needs to be confirmed for sensory terms. Therefore, it might be interesting to examine to which extent the term selection might influence the measurements and if there is a difference in how consumers perceive the profiling task when working with either a consumer-generated list or standardized list. The use of a standardized list has the profit that it saves money and time, which is of course of particular interest for food companies who want to have quick and cheap results (Meiselman, 2015). Also, this doctoral thesis has opted to focus on emotional conceptualisations which gives the opportunity to also include *functional and abstract conceptualisations*. It might be interesting to include measurements about the current mood when conducting the emotional profiling task as performed by Danner *et al.* (2016). Lastly, future research could opt to include more constructs regarding *consumer behaviour* which might help to unravel the drivers of food choice. Given that the EmoSensory® Wheel also includes measurements regarding emotional conceptualisations, questions related to emotional eating behaviour might be of special interest for future research.

A second limitation is related to the **persons** which have participated in the studies described in this doctoral thesis. Because convenience sampling methods were used, the research findings need to be interpreted within their specific sampling frame, and further validation is needed in order to extrapolate to other populations. There is especially a big need to examine to which extent information and context potentially influence food product experience by consumers of other cultures. Some studies have already examined the application of standard emotion lists between different countries which found intercultural differences such as more discrimination between products for positively valenced terms in English speaking terms while the discrimination was equal for positively and negatively valenced terms in Spanish speaking terms (van Zyl & Meiselman, 2015). One should also consider that the same language can lead to different interpretations when persons of different cultures are involved, as reported in findings by van Zyl and Meiselman (2016). Next to other cultures, it might be interesting to investigate if the EmoSensory® Wheel can also be applied with children. Indeed, a recent review by Laureati, Pagliarini, Toschi, and Monteleone (2015) sees emotional and sensory profiling as an interesting research challenge for the next couple of years. Also, there is need for repeating the studies on a larger scale, with a higher number of participants from different socio-economic backgrounds in a variety of geographical locations. Such large scale studies will make it possible to examine if different segments of consumers can be determined based upon their product experience. A study performed by den Uijl, Jager, de Graaf, Waddell, and Kremer (2014) discovered four different segments of elderly based upon the emotions associated with the mealtimes. Another limitation is that the studies presented in this doctoral thesis have opted to only include product users based upon suggestions from previous research (King & Meiselman, 2010). The inclusion of non-product users might therefore offer new insights and possibly also other segments.

The third limitation is related to the **products** which have been used in the different studies of this doctoral thesis. Although the discriminatory ability of the EmoSensory® Wheel has been illustrated with a variety of product categories, more research is needed with other food product categories in order to know if the results can be replicated. Often, highly likable snack products are used in experiments about emotional conceptualisations as one assume that they evoke more emotions with consumers (Jiang *et al.*, 2014). The studies described in this doctoral thesis included less such products, which might have influenced the emotional profiling by for instance having less discriminating terms and lower intensity rates. Also, it might be interesting to examine if the tool is really able to anticipate market failures given that it shows its usefulness in predicting food choice. The application of the EmoSensory® Wheel to conduct flop analysis, perhaps the most efficient process to reduce future product failure (Köster, 2012), with a newly developed product would be an interesting possibility for future research. Future research should also go broader than individual food products but work with whole menus if possible. Results obtained from such measurements could then be compared with actual food consumption (assessed by for instance a food frequency questionnaire) but also for instance with the validated web-buffet tool (Bucher & Keller, 2015).

The fourth limitation is related to the **information** which was used. The studies described in this doctoral thesis have focused on 3 types of information: health-related labels, main ingredient information and brand information. It is recommended that future research also examines the influence of other intrinsic, extrinsic and credence cues. Written information (Chapter 2, 5, 6) and brand logo (Chapter 4,7) was used as way to present the information cues in this doctoral thesis. Future studies might expand scientific knowledge by examining to which extent the way of presenting information influence consumers' product experience. For instance, it might be interesting to examine if the insect burgers would still be better liked under the informed condition when consumers actually saw a picture of the mealworms or for instance the real worms. One could also introduce more detailed information such as a promotional video or an audio commercial to investigate if those marketing tools could alter especially the emotional conceptualisations associated with an informed evaluation. Next to brand logo, it could be interesting to conduct a study with other logos in a more international context. Interesting possibilities lies in working with for instance the fair trade symbol, European Protected Designation of Origin symbol and the EU organic leaf. The purpose of this doctoral thesis was to examine the influence of individual information cues, but it would be interesting to get a broader view and study for instance the use of multiple cues.

The fifth limitation involved the **context** in which the studies took place. One should bear in mind that most studies took place in an laboratory environment in order to standardize the testing as much as possible but this might lower the ecological validity of the tests. However, part II about the validation of the tool included an experiment at a trade fair while also Chapter 6 compared the influence of brand information in two contexts (CLT vs. HUT). Although these chapters gave an indication about the applicability of the tool in contexts and the possible influence of brand information, further research is recommended with other information cues and product categories to obtain a better understanding of the context influence. One should note that context include both social environments and physical environments in the food choice process model as defined by Sobal and Bisogni (2009) (see 1.3.1). However, the context has been limited to a CLT vs. HUT in chapter 6 based upon the available resources. Future research could work with more contexts and delve deeper into contextual differences by for instance asking for a description of the evaluation context. Also, new technical developments provide the opportunity to introduce immersive or even a virtual immersive evaluation context (Jaeger *et al.*, 2016). The use of such an immersive evaluation context makes it possible to let people submerge in a different environment so that they use all their senses for the evaluation of food. This will make it possible to better capture consumers' food experience while still evaluating the product samples in a more controlled environment.

This doctoral research started with the problem statement that current sensory methodology is often too limited to predict actual food choice. While this doctoral thesis examines context and information effects on consumers' food experience, it did not include measurements to examine the actual **food choice** which would be an interesting direction for future research.

There are several possibilities for measuring the real effects on food choices. A first setup is to let people first conduct the emotional and sensory profiling task after which they have the possibility to choose the product they prefer as a 'gift' (so that they do not know that choice is actually part of experiment). Another possibility is to have a separate session during which consumers may actually select and consume the product they preferred, following the experimental design applied by Dalenberg *et al.* (2014). One should also consider the potential influence of the evaluation context such as established by Gutjar, Dalenberg*, et al.* (2015) who examined the predictive value of emotional profiling on food choice in a simulated canteen environment under a blind and package condition. The aforementioned study took not place in the standardized laboratory environment, so it might also be interesting to examine the food choice at several locations such as laboratory, at home or at a supermarket. However, crucial is how food choice would be measured. It is possible to only ask for their final choice or preference such as during a conjoint experiment but it might be more interesting that a person actually needs to make a choice which has consequences to ensure a higher involvement by the respondents.

However, in order to successfully studying food choices a **multidisciplinary approach** is recommended. The EmoSensory® Wheel with the consumption of products is an example of a multidisciplinary approach as it combines psychology and food sciences. Extending the wheel format by including also abstract and functional conceptualisations will also be a step to collect more valuable data for multidisciplinary research.

As mentioned above, there is also a need to better integrate consumer behaviour questions with sensory research to obtain a better understanding of food motives which exemplifies the need for experts in the psychological area. As an example, one could integrate the Food Choice Questionnaire (Steptoe, Pollard, & Wardle, 1995) to obtain a better understanding of how general motives for food choices might influence sensory research. For a more specific setup, such as examining emotional eating, one could opt to include more specific questions such as including the Dutch Eating Behaviour Questionnaire (van Strien, Frijters, Bergers, & Defares, 1986). Also, future research might consider obtaining additional information on consumer's food choice by using a food frequency questionnaire which is often used in the field of nutrition and epidemiological research. Researchers could even choose to work with a dietary record. Including such methods might offer interesting insights and enables the necessary interaction with other scientific disciplines when studying food choices.

Further, food choice is also driven by other more economical driven factors such as price, packaging etc. Although a first step has been set in this doctoral thesis by examining the influence of brand, it might be interesting to go further and also include other important economical attributes of food products such as price in further research. An interesting possibility might be the inclusion of conjoint analysis to determine to which extent certain extrinsic cues (such as price, brand, package size, taste…) are important for the food choice of a certain product and then focus on the most important cues during a second part of the

research design. De Pelsmaeker, Dewettinck, and Gellynck (2013) advocated the addition of tasting during choice experiments which are mainly applied in the field of economical sciences. Another technique which is of interest for providing more insights in food choice is eye-tracking. If eye-tracking is applied in a real (e.g. supermarket) or simulated consumption context (e.g. simulated store shelf), one could obtain more information on how consumers choose a certain product (e.g. is it for instance based upon habit what is the case for most food products or is a more cognitively involved decision process) and the relative importance of certain package characteristics for choice.

Not only the above mentioned methods could offer new understandings regarding consumers' food choice motives, future research should also consider the inclusion of other more implicit measurements which are primarily applied in the field of psychological and neurosciences. The inclusion of implicit measurement techniques such as autobiographical reaction time based on mood congruency, electrodermal activity, EEG and fMRI (Mojet *et al.*, 2015) could allow to delve deeper into the real motivations for food choice as food science nowadays mainly applies explicit measurement techniques.

Given the global challenges such as the increase of overweight, there is certainly a need for a multidisciplinary approach with collaboration between specialists of the fields of nutrition, marketing, psychology and food sciences. The growing importance of new digital methods for data collection raises opportunities to even cooperate with experts from the field of computer sciences to study food choice.

Nevertheless the aforementioned limitations, this doctoral thesis has introduced a promising method to obtain a better and more global understanding of how consumers experience food products.

7.4. References

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Curriculum Vitae

Curriculum vitae

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M.Sc. Thesis: Influence of brand, emotions and sensory attributes on children's flavoured milk consumption (promotor: prof. X. Gellynck, Department of Agricultural Economics)

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Conference contributions

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De Steur, H., Schouteten, J. J., & Gellynck, X. (2016, 26-29 June) GMO-free labelling: consumer preferences and impacts on emo-sensory perceptions. Paper presented on the 19th International Consortium on Applied Bioeconomy Research, Ravello, Italy.

De Pelsmaeker, S., Schouteten, J. J., Lagast, S., & Gellynck, X. (2015, 23-27 August). Tasting or non-tasting in conjoint analysis: is taste the key driver for purchase intent of consumers? Oral presentation on the 11th Pangborn Sensory Science Symposium, Gothenburg, Sweden.

Lagast, S., De Pelsmaeker, S., Schouteten, J. J., & Gellynck, X. (2015, 23-27 August). Local food products in health care facilities: elderly sensory acceptance of a local food menu. Poster presentation on the 11th Pangborn Sensory Science Symposium, Gothenburg, Sweden.

Lagast, S., De Steur, H., Schouteten, J. J., De Pelsmaeker, S., & Gellynck, X. (2015, 23-27 August). Emotional connotations of consumers in blind sensory evaluation of chocolates with normal and alternative sweeteners. Poster presentation on the 11th Pangborn Sensory Science Symposium, Gothenburg, Sweden.

Schouteten, J. J., De Pelsmaeker, S., Lagast, S., De Bourdeaudhuij, I., & Gellynck, X. (2015, 23-27 August). Effect of health labelling on expected and actual taste perception of cheese. Poster presentation on the 11th Pangborn Sensory Science Symposium, Gothenburg, Sweden.

Schouteten, J. J., De Steur, H., Lagast, S. , De Pelsmaeker, S., & Gellynck, X. (2015, 23-27 August). Linking emotions and sensory attributes of traditional food products: an application of the CATA approach in a study on children. Poster presentation on the 11th Pangborn Sensory Science Symposium, Gothenburg, Sweden.

Schouteten, J. J.; Vella, A., De Clercq, N., Van Durme, J., Lagast, S., De Pelsmaeker, S. Dewettinck, K., & Gellynck, X. (2015, 23-27 August). Linking instrumental, sensory and emotional evaluation of flavoured chocolates. Poster presentation on the 11th Pangborn Sensory Science Symposium, Gothenburg, Sweden.

Schouteten, J. J., De Pelsmaeker, S., Courtois, V., & Gellynck, X. (2014; 7-10 September). Consumers' hedonic expectations and healthiness' perception of chocolate with natural and artificial sweetener. Poster presentation on EuroSense 2014 A Sense of life – 6th European Conference on Sensory and Consumer Research, Copenhagen, Denmark.

Lagast, S., Schouteten, J. J., De Pelsmaeker, S., & Gellynck, X. (2014, 11-13 May). Relation between sensory characteristics and consumer preference for traditional Belgian cheeses. Poster presentation on SenseAsia 2014 The Asian Sensory and Consumer Research Symposium, Singapore.

Schouteten, J. J., De Pelsmaeker, S., Lagast, S., & Gellynck, S. (2014, 11-13 May). Sensory evaluation of fresh, canned and frozen French beans by children. Poster presentation on SenseAsia 2014 The Asian Sensory and Consumer Research Symposium, Singapore.

Schouteten, J. J., De Pelsmaeker, S., Lagast, S., & Gellynck, X. (2014, 11-13 May). Can emotions deliver additional information on the informed liking of flavoured milk by children? Oral presentation on SenseAsia 2014 The Asian Sensory and Consumer Research Symposium, Singapore.

Juvenal, J. G., De Pelsmaeker, S., Schouteten, J. J., & Gellynck X. (2014, 26-28 April). Influence of Chocolate Texture on Belgian Consumers' Emotions and Affective Ratings. Oral presentation on the International Conference on Integration of Science and Technology, Shenzhen, China.

De Pelsmaeker, S., Behra, J. S., Schouteten, J. J., & Gellynck, X. (2014, 30 March – 2 April). Difference in threshold detection of graininess in chocolate: machine vs human. Oral presentation on the Food Structure and Functionality forum Symposium, Amsterdam, Netherlands.

Lagast, S., Schouteten, J. J., De Pelsmaeker, S., & Gellynck, X. (2014, 30 March – 2 April). Sensory differences between low-fat and regular yogurt measured by instrumental analyses and consumer evaluation. Poster presentation on the Food Structure and Functionality forum Symposium, Amsterdam, Netherlands.

Schouteten, J. J., De Pelsmaeker, S., Juvinal, J. G., & Gellynck, X. (2014, 30 March – 2 April). Influence of chocolate texture on Belgian consumers' emotions and affective ratings human. Poster presentation on the Food Structure and Functionality forum Symposium, Amsterdam, Netherlands.

Nguyen Tuyet, M., De Pelsmaeker, S., Schouteten, J. J., Gellynck, X., & Dewettinck, K. (2013, 11-13 November). Potential of milk polar lipids in chocolate products: sensory and instrumental evaluation. Developing the Supply Chain Towards More Healthy Food, VBfoodNet conference, Hanoi, Vietnam.

International experience

Visiting PhD scholar: Copenhagen University (Denmark), Department of Food Science, Section for Food Design and Consumer Behaviour, 19 November 2015 – 18 February 2016

Erasmus Intensive Program Sustainable utilization of renewable resources University of Graz (Austria), 4 July – 15 July 2011

Awards and grants

- FWO travel grant long stay abroad (2015 -2016 Copenhagen University)
- Young researcher award (Pangborn 2015 conference)
- Best Paper in the category: Applied Techonologies (International Conference on Integration of Science and Technology -2014)
- Verbondsprijs 2012

Supervision of master thesis students

Bollaert, B. (2016). Smaken A-merken echt beter dan huismerken? Thesis to obtain the degree of M.Sc. in Bioscience Engineering. Ghent University.

Nys, S. (2015). Invloed van attitudes, emoties, sensorische eigenschappen op de smaakvoorkeur van het streekproduct speculoos. Een vergelijkende casestudie tussen kinderen en volwassenen.. Thesis to obtain the degree of M.Sc. in Bioscience Engineering. Ghent University.

Courtois, V. (2014). Chocolade met en zonder stevia: identificatie van de smaakperceptie en gedrag van consumenten Thesis to obtain the degree of M.Sc. in Bioscience Engineering. Ghent University.

Supervision of bachelor thesis students

Raat, H., Temmerman, H., Tytgat, J., & Van Asbroeck, L. (2016). Je proeft wat je ziet. Verandert GGO-vrije labeling de smaakbeleving? Promotors: prof. X. Gellynck and dr. H. De Steur. Thesis to obtain the degree of B.Sc. in Bioscience Engineering. Ghent University.

Segers, J., Van de Velde, W., Vercoutere, T., & Verheye, I. (2015). Insecten op ons bord: smaken mensen het verschil? Promotor: prof. X. Gellynck. Thesis to obtain the degree of B.Sc. in Bioscience Engineering. Ghent University.

Lectures and educational involvement

Involved in the exercises and practicals of the course Sensory Analysis (Ghent University – starting from academic year 2012-2013)

Presentation at Intrafood 2016 (Kortrijk – 22th September)

Invited lectures: STI Humanitarian Food Science and Technology: Sensory analysis (Ghent – 19th September 2014) and Consumers' food experience (Copenhagen – 7th January 2016 – Sensory and Consumer Science course)